ANNOTATED PRAIRIE DOG BIBLIOGRAPHY 1973 to 1985

July 1986

Montana BLM Wildlife Technical Bulletin No. 1

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BY

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INTRODUCTION

An up-to-date working knowledge of prairie dogs (*Cynomys sp.*) is essential for natural resource managers, especially those managing public lands and national grasslands. Much of the scientific basis for enhanced prairie dog management is derived from the references included in this bibliography. This bibliography can serve land and wildlife managers with an up-to-date, easily accessible description of the scientific literature on prairie dogs printed in the last 13 years. This should make the manager's job easier.

Five species of prairie dogs are recognized in North America. They are the black-tail (*Cynomys ludovicianus*), Mexican (*C. mexicanus*), Gunnison (*C. gunnisoni*), white-tail (*C. leucurus*), and Utah (*C. parvidens*). They vary considerably in their ecology and behavior. Prairie dogs reached their peak distribution and numbers in modern times around 1920. They occupied about 100 million acres in 12 states and two Canadian Provinces. All five species have been reduced significantly since then, and today the Mexican species is endangered and the Utah species is threatened (formerly listed as endangered). The other three species have been reduced by an estimated 75 to 90+ percent over their former ranges. However, prairie dogs still exist in relatively large numbers and are a major component of the grassland ecosystem in some areas.

More than 100 vertebrate and scores of invertebrate species have been recorded on prairie dog towns. Several birds and mammals depend on prairie dogs for food, their burrows for shelter, or for other vital life history requirements. The endangered black-footed ferret (*Mustela nigripes*) is nearly totally dependent on prairie dogs. The mountain plover (*Charadrius montanus*), swift fox (*Vulpes velox*) and a few other species seem dependent on prairie dogs too. These complex community relationships need further study.

Prairie dogs themselves play a complex role in the grassland ecosystem as they influence soil formation and fertility, and vegetation production and dynamics. This has implications for the livestock and agricultural industries where the prairie dog interacts with crop, cattle and sheep production. Prairie dog-range relationships have always been a controversial topic. Since the latter part of the last century, prairie dogs have most often been considered "range pests" and have been the focus of intensive and extensive control programs.

Limited discussion of the ecological role of prairie dogs in the grassland ecosystem, based on a growing scientific understanding, started in the late 1940s and 1950s. But only in the last 15 years has systematic scientific investigation of prairie dog-range relationships been carried out. As a result of these studies prairie dogs are now viewed more objectively. In the last 8 years, the economic and ecologic relationships of prairie dogs have been the focus of many studies. Because prairie dogs have mixed ecologic, economic, scientific, natural heritage, and aesthetic values, the management task of balancing these values is not always an easy one, as land and wildlife managers well know.

Only two prairie dog bibliographies have been produced previously. The first, in 1971 by T. W. Clark (Towards a literature review of prairie dogs, Wyoming J. Range Mgmt. No. 286(Mar.-Apr.):29-44) and the second, in 1973 by F. Hassien (Prairie dog bibliography, Black-footed ferret and prairie dog workshop, South Dakota State University, Brooking, 208 pp.). Fred Hassien's bibliography was later reprinted as a Bureau of Land Management Technical Note (279, January, 1976). Neither of these bibliographies was annotated.

This annotated bibliography takes up where the two previous ones left off, beginning with literature in 1973 and ending with 1985. Nearly all of the citations are from published literature. Abstracts, highlights, synopses, or summaries are listed for most entries. The 201 citations are categorized by subject as follows:

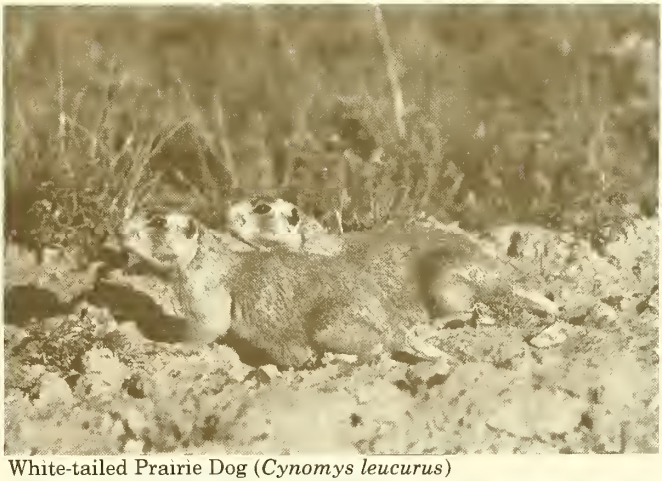
GENERAL: 18, 31, 46, 83, 116, 120, 131, 134, 136.
DESCRIPTION AND DISTRIBUTION: 19, 47, 54, 55, 64, 79, 83, 85.
ECOLOGY: 2, 4, 12, 13, 14, 15, 24, 25, 26, 27, 29, 32, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 49, 56, 57, 58, 60, 61, 70, 72, 73, 74, 76, 81, 97, 98, 102, 103, 104, 105, 106, 107, 109, 110, 112, 113, 117, 125, 126, 139, 140, 151, 159, 160, 162, 163, 164, 172, 173, 181, 182, 183, 184, 185, 186, 193, 198, 199, 200, 201.
BEHAVIOR: 1, 5, 9, 28, 30, 52, 63, 65, 66, 67, 77, 80, 87, 88, 89, 90, 91, 92, 93, 94, 96, 114, 118, 119, 120, 127, 135, 138, 141, 145, 152, 154, 155, 156, 161, 180, 196.
MORPHOLOGY AND PHYSIOLOGY: 3, 6, 7, 8, 16, 17, 20, 21, 22, 23, 50, 68, 69, 71, 78, 100, 115, 123, 124, 129, 132, 133, 147, 150, 153, 194, 195.
PARASITES AND DISEASE: 93, 120, 189.
MANAGEMENT: 10, 11, 34, 35, 48, 51, 53, 59, 62, 75, 84, 86, 95, 99, 108, 111, 121, 122, 137, 142, 143, 144, 146, 148, 149, 157, 158, 165, 166, 167, 168, 169, 170, 171, 174, 175, 176, 177, 178, 179, 187, 188, 189, 190, 191, 192.

FOUR SPECIES OF PRAIRIE DOGS

Black-tailed Prairie Dog (*Cynomys ludovicianus*)
Photo by Tim W. Clark.

Utah Prairie Dog (*Cynomys parvidens*)
Photo by Tim W. Clark.

Gunnison's Prairie Dog (*Cynomys gunnisoni*)
Photo by J. Perley Fitzgerald.



White-tailed Prairie Dog (*Cynomys leucurus*)
Photo by Tim W. Clark.

ANNOTATED PRAIRIE DOG BIBLIOGRAPHY
1973 to 1985

1. Adams, R. A., B. J. Lengas, and M. Bekoff. 1984. Variations in the threshhold of anti-predatory responses in black-tailed prairie dogs (*Cynomys ludovicianus*). Amer. Zool. 24:3A.

Four populations of black-tailed prairie dogs (*Cynomys ludovicianus*) consisting of two fairly isolated 'country' groups and two 'city' groups surrounded by urban sprawl, were studied to determine if there were any differences among them in anti-predatory responses shown to an approaching human. Country prairie dogs were more wary and less tolerant of human intrusion and reacted more strongly to human disturbance than did city dwellers. Results supported King's (1955) suggestion that variations in antipredatory behavior of black-tailed prairie dogs are in the threshold of stimuli that release the response and not in the pattern of the reaction itself.

2. Agnew, W. 1983. Flora and fauna associated with prairie dog ecosystems. M.S. Thesis, Colorado State Univ., Fort Collins, 47 pp.

Vegetation, small mammals, birds and macroarthropods were sampled over two years on prairie dog colonies and mixed grasslands in western South Dakota. Prairie dog grazing favored an increase in forb production relative to percent canopy cover, although the number of forb species was greater on ungrazed mixed grasslands. Vegetative-litter cover and maximum vegetative height were significantly lower on prairie dog towns. Buffalograss (*Buchloe dactyloides*) was the dominant plant on prairie dog towns and western wheatgrass (*Agropyron smithii*) was most common on mixed grasslands.

Deer mice (*Peromyscus maniculatus*) and northern grasshopper mice (*Onychomys leucogaster*) were the most common small rodents of the seven species captured. They were more abundant on prairie dog towns than mixed grasslands. Prairie dog towns attracted more individual small mammals but a fewer number of species.

Avian density and species abundance was greater on prairie dog towns than mixed grasslands. Prairie dog clipping activity increased avian species associated with low cropped vegetation. Horned larks (*Eremophila alpestris*) were most common on prairie dog towns and western meadowlarks (*Sturnella neglecta*) on mixed grasslands.

Macroarthropod densities were highly variable throughout the growing season and between years on prairie dog towns and mixed grasslands. Ants (Hymenoptera Formicidae) were the most common macroarthropod on both treatments. (abstract)

3. Althen, C. L. 1975. The interaction of circadian rhythms and thermal stress in controlling activity in the black-tailed prairie dog. Ph.D. Dissert., Univ. Colorado, Boulder, 168 pp.

Black-tailed prairie dogs (*Cynomys ludovicianus*) exhibit distinctly different patterns of diurnal activity at different times of the year. Several areas of investigation were employed to determine the relationships of endogenous and exogenous factors in controlling the seasonal patterns of diurnal activity.

A central principle governing the activities of prairie dogs is that their time-energy budget minimizes their exposure to thermal stress above ground. By minimizing their exposure to thermal stress, prairie dogs minimize metabolic energy demands, the amount of time necessary for foraging, the amount of forage required, and maximize the carrying capacity of the colony's territory.

The time-energy budget for above-ground activity is controlled by an endogenous circadian pattern of activity and exogenous thermal factors. The relative importance of these two key factors in controlling activity is seasonally dependant; thermal factors are potentially dominant.

All environmental factors which show daily variation influence activity by their common effect on thermal energy exchange; they are of little consequence in controlling activity otherwise.

The established patterns of activity in prairie dogs reported in the literature can be augmented in three ways. There is a tendency towards a bi-modal pattern of activity at all times of the year. But, the pattern is predominantly unimodal during the winter, and there are usually smaller additional cycles during the summer. Because of thermal influences, the maximum level of activity occurs in the afternoon during the winter and in the morning peak during the summer. The midday lapse in activity between the peaks broadens as the periods of thermoneutral conditions diverge from midday.

4. Archer, S. R., I. D. Lebreton, M. G. Garrett, and J. K. Detling. 1984. Structural changes in a mixed-grass prairie plant community as a function of prairie dog colonization history. Bull. Ecol. Soc. Am. 65(2):162.

Ordination techniques were used on vegetation data collected from a 6-year-old prairie dog colony in western South Dakota to quantify the impact of heavy grazing on plant community structure. Modification of community structure, evidenced by changes in species composition and importance, occurred differentially in stands with colonization histories of 0, 2, 3 and 4 to 6 years. Total plant diversity increased by 63 and 126 percent during the initial 2 and 3 years of colonization, respectively. After 4 to 6 years, diversity decreased to 84 percent of uncolonized stands. These changes were accompanied by a 360 percent increase in bare soil and a 60 percent decrease in litter accumulation. Significant reductions in plant stature, which occurred within 2 years of colonization, were largely the result of a shift from tall growth forms of off-colony species to dwarf growth forms on the colony. In a broader context, these data illustrate the rate and magnitude of change in plant community structure that may result from activities of a native grassland herbivore that was once widely distributed.

5. Armitage, K. B. 1981. Sociality as a life history tactic of ground squirrels. Oecologia 48:36-49.

Multi-variate analysis of life-history traits of 18 species of burrowing sciurids indicates that reproductive effort is determined by body-size energetics. Other traits, such as age adult weight reached, age of dispersal, length of time of gestation, were significantly correlated with body size. A principal component analysis suggested that the complex of life-history traits could be reduced to four components: body size (=weight), seasonality, specific reproductive effort, and

maturity. The variation in the sociality index was best explained by age of first reproduction and age adult weight reached. Generally, species are more social when large body size combined with a relatively short growing season is associated with delayed dispersal and occurs in those species typically breeding for the first time at age two or older. Sociality in these species may have evolved through retention of daughters within the maternal home range as a means of continuing reproductive investment beyond weaning.

6. Bakko, E. B. 1977. Field water balance performance in prairie dogs (*Cynomys leucurus* and *C. ludovicianus*). Comp. Biochem. physiol. 56A:443-451.

Field samples of urine, blood plasma, and kidneys were collected seasonally from white-tailed prairie dogs (*Cynomys leucurus*) and black-tailed prairie dogs (*C. ludovicianus*).

Maximum field urine osmolalities for black-tailed prairie dogs were significantly below maximum urine osmolalities for that species under laboratory water deprivation. However, white-tailed prairie dogs produced field urine concentrations that did not differ from maximum urine osmolality collected under laboratory water deprivation except during June.

Black-tailed prairie dogs demonstrated greater urine concentrating ability than white-tailed prairie dogs as evidenced by kidney relative medullary thickness and by urine concentration under water deprivation. Survival time under water deprivation was higher for black-tailed prairie dogs. Potassium, sodium, urea, and ammonia concentration in urine are discussed. Blood plasma osmolality and plasma potassium, sodium, and urea concentrations are discussed.

It is argued that white-tailed prairie dogs, although living in a more xeric habitat than black-tailed prairie dogs, are not as well adapted to withstand water stress and probably rely on seasonal torpor. Black-tailed prairie dogs, while occupying a more mesic habitat, are better adapted to water stress and therefore are able to remain active throughout the year. This, in turn, enables continuous social contact in this species and subsequent high social organization. (abstract)

7. Beckstead, M. 1977. Digestibility of common forage plants and energetic requirements of the black-tailed prairie dog. M. S. Thesis, South Dakota State Univ., Brookings, 39 pp.

Black-tailed prairie dogs (*Cynomys ludovicianus*) assimilated 51.5 percent of the wheatgrass (*Agropyron intermedium*) they consumed; thus, they would have to consume 0.148 kcal/g/day in order to obtain the 0.076 kcal/g/day they would require to maintain their weight. Prairie dogs assimilated 31.5 percent of the buffalograss/blue grama mixture (*Buchloe dactyloides*/*Bouteloua gracilis*) they were fed. They would have to consume 0.229 kcal/g/day of this forage to assimilate 0.072 kcal/g/day and maintain their weight.

The proximate composition of forages fed in feeding trials was similar to that found for those collected on the study area. Total digestible nutrients (TDN) for wheatgrass in feeding trials and from the study site averaged 46.7 percent and 45.5 percent, respectively. The mean TDN for buffalograss/blue grama feeding trial and study area forages were 26.4 percent and 23 percent, respectively.

The assimilation efficiency (AE) of prairie dogs on their natural diet of 34 percent forbs and 65 percent grasses was 71.8 percent. The higher AE in the wild population than in captive animals fed grasses is due to the presence of highly digestible forbs.

The estimated Resting Metabolic Rate (RMR) of 0.056 kcal/g/day is relatively low; 85 percent of the Basal Metabolic Rate as predicted by a metabolic body size formula. The energy cost of activity is the primary cause for the difference in RMR estimates from oxygen consumption tests and caloric requirements found in feeding trials. The prairie dog feeding trial results were 1.32 times greater than the RMR estimates. (abstract)

8. ———, and F. Schitoskey, Jr. 1980. Assimilation efficiency of the black-tailed prairie dog. Proc. South Dakota Acad. Sci. 59:184-194.

Captive prairie dogs (*Cynomys ludovicianus*) maintained on an intermediate wheatgrass (*Agropyron intermedium*) diet assimilated 51.5 percent of available dry matter; on a mixture of buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*) they assimilated 31.5 percent of available dry matter. The assimilation efficiency of wild prairie dogs on a natural diet of forb and grass combinations was 71.8 percent.

The black-tailed prairie dog (*Cynomys ludovicianus*) is a colonial sciurid of the Great plains. Well-defined social behavior patterns lead to the establishment of dog towns and may result in concentrations that influence local plant succession. Prairie dog activities appear to increase the diversity of both perennial and annual plant species as well as the abundance of forbs and grazing-resistant grasses. Soil is improved by the addition of prairie dog urine, feces, carcasses, and clipped plant parts. Prairie dogs contribute to range deterioration by eating the basal parts of some plants, digging for roots, and eliminating vegetation in some areas.

Prairie dogs are opportunists in the sense that their diet varies with plant abundance, colony location, and season. Kelso in Montana, Koford in Colorado, and Smith in Kansas found that various grasses composed two-thirds to three-fourths of the summer diet. King concluded that forbs were the principal summer food in his study area in South Dakota. Prairie dogs consumed 65 percent grasses, 34 percent forbs, and less than 5 percent seeds and insects in the Conata Basin. On an annual basis, western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), and buffalograss (*Buchloe dactyloides*) formed 48 percent of the diet, and scarlet globemallow (*Sphaeralcea coccinea*) contributed another 18 percent. Prickly pear (*Opuntia polycantha*), indianwheat (*Plantago spp.*), and threadleaf sedge (*Carex filifolia*) were seasonally important, but each constituted less than 10 percent of the annual diet.

Objectives of the present study were to determine the assimilation efficiencies of captive black-tailed prairie dogs on a grass only diet and wild prairie dogs on a natural diet.

9. Bernstein, P. L. 1978. Abundantly performed displays the tail as a source of information in black-tailed prairie dogs (*Cynomys ludovicianus*). Ph.D. Dissert., Univ. Pennsylvania, Philadelphia, 157 pp.

Interpretation of abundantly performed displays could broaden our understanding of communication, which has been based for the most part on studies of less abundantly performed display acts. Abundantly performed tail displays of the black-tailed prairie dog (*Cynomys ludovicianus*) were examined in detail to aid in such interpretation. Tail positions and movements were examined as nearly continuously available sources of information in this species, with particular emphasis placed on analyzing the kinds of information made available by the tail displays. Analyses were done within the "message" framework established by W. J. Smith, as discussed in his book, "The Behavior of Communicating: An Ethological Approach" to facilitate comparison with other displays and with Smith's "widespread message list."

Several tail displays, involving tail positions and flicking movements, were identified in both wild and captive populations of *C. ludovicianus*. Each display in turn was found to correlate consistently with particular patterns of communicator behaviors. The question was asked whether abundantly performed displays would correlate with the same kinds of communicator behavior patterns found to correlate with other, less abundantly performed displays, or with different patterns. One display does correlate with what may represent a new set of kinds of behavior, "information gathering." Two of the displays provide unusual combinations of messages. Flicking provides information about "locomotion," evidence that mammalian displays provide this message first identified in bird studies. The extreme end of the flicking range provides information about "escape" behaviors as well. The frequency of occurrence of tail positions was seen to vary in appropriate ways over the course of an annual cycle of black-tailed prairie dog social behavior.

Comparison with tail positions and movements of other sciurids as discussed in the literature reveals some similarities in tail display form and patterns of use within this family. However, the complexity and abundance of tail displaying in *C. ludovicianus*, the most social species (with its sister species *C. mexicanus*) within the family, seems unusual. Comparison with the abundant tail displaying of a social, savannah-dwelling primate, *Cercopithecus aethiops*, reveals some similarities and some differences between these species in form and patterns of occurrence of abundant tail displays.

10. Bishop, N. G., and J. L. Culbertson. 1976. Decline of prairie dog towns in southwestern North Dakota. J. Range. Mgmt. 29(3):217-220.

Aerial photographs for 1939 to 1972 were examined to evaluate the impact of rodent control programs and land use practices on prairie dog towns on a portion of the Little Missouri National Grasslands. Colonies were measured for three periods during the 33-year span and showed an 89 percent decline in number and a 93 percent decline in acreage. Average town size was not significantly affected during the decline and was not significantly different on federal land compared to private or state land. Colonies were largely eliminated on the best agricultural bottom lands but appeared to be more persistent near the undisturbed colonies in Theodore Roosevelt National Memorial Park. Reported sightings indicate that some black-footed ferrets have probably survived in the area. The new perspective has resulted in improved management for the two species. (highlight)

11. Boddicker, M. J. 1977. Managing prairie dog populations. Colorado State University Extension Service, Ft. Collins, Service in Action, No. 6.506, 2 pp.

Three species of prairie dogs live in Colorado. Colorado prairie dogs are prolific, common to abundant, depending upon the area, and are not threatened or endangered. The black-footed ferret, presently classified as endangered in the United States, is dependent upon prairie dogs for existence. Prairie dogs can be controlled by selective shooting, use of poisoned grains, fumigants and careful management of grasslands. Prairie dogs do not thrive in tall grass and heavy vegetation. Prairie dogs serve as reservoirs of bubonic (black) plague and tularemia, both serious human diseases. (summary)

12. _____, and A. Lerwick. 1976. Vegetation changes induced by prairie dogs on shortgrass range. J. Range. Mgmt. 29(3):221-225.

This study documented some effects of prairie dogs on a shortgrass type of the Central Plains Experimental Range approximately 35 miles northeast of Fort Collins, Colorado, and an adjacent area. Prairie dogs changed the plant species composition of the two sites studied, but these changes were not all detrimental. Species diversity was greater and some plant species used by livestock were more abundant inside than outside the prairie dog towns. (abstract)

13. _____, and J. S. Hannan. 1978. Blue grama and Buffalograss patterns in and near a prairie dog town. J. Range. Mgmt. 31(1):63-65.

Blue grama and buffalograss patterns differed in response to prairie dog mound building activities. While both species exhibited smaller pattern sizes within prairie dogs towns compared to outside, but adjacent areas, the size of clumps and patches differed for the two species. Prairie dog activities caused a two-fold decrease in pattern size of blue grama by reducing size of clumps and patches. On the other hand, buffalograss patches were fragmented into small clumps which were not observed outside the town. (abstract)

14. Brizuela, M. A., J. K. Detling, and M. S. Cid. 1984. Seasonal silicon content of grasses from sites receiving different grazing pressure by grassland herbivores. Bull. Ecol. Soc. Amer. 65(2):161-162.

Plants of *Agropyron smithii* (western wheatgrass) and *Schizachyrium scoparium* (little bluestem) were collected monthly, from May to September, in sites with different grazing histories in Wind Cave National Park, South Dakota. Shoot silicon concentration, expressed as percent of dry matter, was determined colorimetrically. Silicon concentrations were always greater in plants growing on heavily grazed prairie dog (*Cynomys ludovicianus*) colonies than in plants from adjacent lightly grazed uncolonized sites. The largest differences ($p<.05$) among sites were observed late in the growing season. In September, Si content of *A. smithii* plants from two colonized sites averaged 2.86 percent, while plants from two adjacent uncolonized sites averaged 2.04 percent. Similarly, shoots of *S. scoparium* plants from a

colonized site and an uncolonized site contained 3.44 and 1.85 percent Si, respectively. Shoot silicon content appears to be affected both by herbivory and local site differences.

15. Campbell, T. M., III, and T. W. Clark. 1981. Colony characteristics and vertebrate associates of white-tailed and black-tailed prairie dogs in Wyoming. Amer. Midland Nat. 105(2):269-275.

Some ecological characteristics of 25 white-tailed (*Cynomys leucurus*) and 21 black-tailed (*C. ludovicianus*) prairie dog colonies in Wyoming were compared. The size of colonies and density of burrow openings were similar for the two species, but the number of white-tailed prairie dog colonies per 100 km were 3.7 and 4.6 times greater, respectively, than for black-tails. The 64 vertebrate species (22 mammals, 33 birds, 5 reptiles, and 4 amphibians) were found on prairie dog colonies. The ecological relationships between prairie dogs and associated vertebrate predator species and the history of prairie dog control in Wyoming are discussed. (abstract)

16. Carlson, R. H., M. G. Sanders, A. Tal, and W. G. Wood. 1975.

Attenuation of "acute" habituation by scopolamine in the black-tailed prairie dog (*Cynomys ludovicianus*). J. Comp. Physiol. Psychol. 88:335-341.

17. Caulfield, J. A., and R. K. Plakke. 1980. Histochemistry of perianal glands in reproductively active black-tailed prairie dogs (*Cynomys ludovicianus*). J. Colorado-Wyoming Acad. Sci. 12(1):41-42.

Black-tailed prairie dogs (*Cynomys ludovicianus*) possess a trilobate perianal gland. Under various conditions each lobe can be extruded by voluntary contraction to form three externally visible ischemic papillae. Each lobe is composed of cellular types exhibiting two modes of secretion: apocrine and holocrine. Histochemical analyses reveal apocrine cells producing secretary products composed of acid mucopolysaccarides and glycogen. Holocrine cells produce secretions composed of protein, phospholipids and free fat (nonconjugated lipids). When compared to perianal glands of nonreproductively active *C. ludovicianus* the glands examined in this study show increased proliferation and activity of holocrine cells and increased secretary activity of the apocrine component. Chemical constituency showed variation in accordance with increased secretary activity in both cell types. Sexual dimorphism was observed in gross or microscopic anatomy. No function has yet been ascribed to this gland; results of this study, however, indicate greater glandular activity during the reproductive season of this species.

18. Chace, G.E. 1973. Prairie dogs, ferrets and cattle—conflict on the plains. Anim. Kingdom, April:2-8.

To the western ranchers, the grass-eating prairie dogs compete for food with cattle. Poisoning the prairie dogs has also killed their predator, the rare black-footed ferret. (summary)

19. Cheatheam, L. K. 1977. Density and distribution of the black-tailed prairie dog in Texas. Texas J. Sci. 29:33-40.

More than 30,000 Agricultural Stabilization and Conservation Service aerial photographs providing coverage in 108 counties in central and western Texas were examined to provide management data on the current population size and distribution of the black-tailed prairie dog (*Cynomys lodovicianus*). In areas of incomplete photographical coverage, individuals knowledgeable of black-tailed prairie dog colony locations were interviewed. A total of 1,336 prairie dog colonies inhabiting 36,432 hectare were located in 89 counties in the study area. Onsite inspections were made at 319 colonies (23.8 percent of total) to verify the colony's presence, size, and location. The average colony size was 27.27 ha. Croplands presently utilize 29.4 percent of the study area's prairie dog habitat. A total of 1,268 burrowing owls (*Speotyto cunicularia*) were observed in 91 of the 319 colonies inspected.

20. Chesser, R. K. 1981. Genetic and morphologic variation within and among populations of the black-tailed prairie dog. Ph.D. Dissert., Univ. Oklahoma, Norman, 97 pp.

Genetic variation for seven variable loci and morphometric variability for 17 cranial characters were analyzed for black-tailed prairie dogs (*Cynomys ludovicianus*) within and between populations in eastern New Mexico. Significant genetic differentiation was found for prairie dogs from populations in close proximity as well as for those from distant parts of their range. The degree of local differentiation of allele frequencies and cranial dimensions was greater than that among regions separated by major geographical barriers. Genetic and morphologic associations between prairie dogs from different populations were not in agreement with proposed taxonomic classifications. Genetic relationships between samples were not significantly associated with those for electrophoretic data. However, the amount of morphometric variability accounted for by differences among samples within four physiographic regions and that among the regions was virtually identical as that measured by electrophoretic data. Significant heterogeneity of allele frequencies was found for prairie dogs from different wards within a population, and for those from different coteries within the wards. The social behavior of prairie dogs has resulted in genetic differentiation over small distances and inbreeding and genetic drift within the social units.

21. ———. 1983. Cranial variation among populations of the black-tailed prairie dog in New Mexico. Occas. Cap. Mus. Texas Tech. Univ. No. 84, 13 pp.

22. ———. 1983. Genetic variability within and among populations of the black-tailed prairie dog. Evolution 37:320-331.

Genetic variation for seven variable loci was analyzed for prairie dogs within and between populations in eastern New Mexico. Significant genetic differentiation was found for prairie dogs from populations in close proximity (5-15 km) as

well as for those from distant parts of their range. The degree of local differentiation was greater than that among regions separated by major geographical barriers. The patterns of genetic similarities between prairie dogs from different populations were not in agreement with proposed taxonomic classifications. Significant heterogeneity of allele frequencies was found for prairie dogs from different wards (portions of a population separated by unsuitable habitat) within a population, as well as for those from different coteries (harem groups) within the wards. The social behavior of prairie dogs has resulted in genetic differentiation over very small distances and rapid inbreeding and genetic drift within the social groups. The mechanisms and consequences for sustaining such fine scale subdivision are discussed.

23. Cid, M. S., J. K. Detling, E. L. Painter, and M. A. Brizuela. 1984.

Controlled environment studies on the potential influences of defoliaton and past grazing history on silicon content of *Agropyron smithii*. Bull. Ecol. Soc. Amer. 65(12):162.

24. Cincotta, R. P., R. M. Hansen, and D. W. Uresk. 1983. Decision theory model for dispersal strategies of female black-tailed prairie dogs. Bull. Ecol. Soc. Amer. 64(2):83.

Decision theory presents a method by which strategies might be numerically analyzed and upon which rational decisions may be based. In our case, we have assumed that natural selection is a "rational" process and submit a dynamic decision theory model as a method of generating hypotheses and possible tests of hypotheses for dispersal strategies in female black-tail prairie dogs (*Cynomys ludovicianus*). Dispersal strategies were assessed over time as to relative fitness, which was computed as a function of relative reproductive payoffs, probability of survival from predation, and probability of survival from effects of a deteriorating environment (e.g., loss of a continuous forage resource base, and greater risk from disease). Simulation results show that no single strategy maintains a selective advantage over the life of an aging prairie dog family group. This suggests a more complex set of cues from which prairie dogs can make an optimal dispersal decision.

25. ——, R. M. Hansen, and D. W. Uresk. 1983. Establishment and expansion of black-tailed prairie dog towns. J. Colorado-Wyoming Acad. Sci. 15(1):49.

26. ——, R. M. Hansen, and D. W. Uresk. 1983. The importance of time and population density in relation to vegetational changes in the pheripheral area of an expanding black-tailed prairie dog town in South Dakota. Soc. Range. Mgmt. Annu. Meeting 36:11.

27. ——, R. M. Hansen, and D. W. Uresk. 1983. Preliminary results of a study on colony expansion among black-tailed prairie dogs in South Dakota. Soc. Range Mgmt. Annu. Meeting 36:118.

28. ——, R. M. Hansen, and D. W. Uresk. 1984. Kin-selected behavior and its effect upon dispersal in the black-tailed prairie dog. Bull. Ecol. Soc. Amer. 65(2):235.

A simplified model of altruistic behavior was applied to individuals living within family units in a black-tailed prairie dog (*Cynomys ludovicianus*) town. The model suggests that forage resources represent the greatest cost for unselfish behavior as family sizes increase. The model also predicts that less resource-limited families may incorporate immigrant (unrelated individuals) with the possibility of greater inclusive fitness for family altruists. Experimentally this prediction was tested by comparing the amount of female immigration accepted by families along the town edge with that accepted by resource-limited interior families. Analysis of the two year experiment, using the multi-response permutation procedure (MRPP), disclosed significantly higher percentages of immigrant females accepted in outside families than in inside families ($p=.98$). The family model is of particular interest, since a specific case of it provides an explanation of the higher level social phenomenon involving groups of families, the prairie dog town.

29. Clark, T. W. 1973. A field study of the ecology and ethology of the white-tailed prairie dog (*Cynomys leucurus*): with a model of Cynomys evolution. Ph.D. Dissert., Univ. Wisconsin, Madison, 215 pp.

Ecological and ethological data are presented from a 1966-1968 study of a white-tailed prairie dog (*Cynomys leucurus*) colony (13.2 hectares) on Hutton Lake National Wildlife Refuge, Wyoming (elev. 2175 meters). In addition, patterns of behavioral evolution in *Cynomys* are discussed in relation to some ecological correlates. Study procedures included determination of habitat structure (vegetation and burrows) and live trapping, marking and observing animals.

Colony vegetation was over 90 percent short grasses and forbs. Burrow openings (N=872) occurred at 57 per hectare. Some range relationships, revegetation of burrow mounds, burrow structure and burrow microclimate were investigated.

Maintenance and social behavior patterns (i.e., motor patterns and context) of locomotion, ingestion, defecation and urination, care of body surface, comfort movements, digging, nest building, alert behavior and agonistic and sexual behavior were described.

Growth and behavioral development were observed. Pups were weighed and instantanous growth rates calculated: 88 percent of adult weight was achieved by 120 days after emergence, and females reached adult proportion faster than males. At first appearance above ground (early June) pups frequently sat motionless near home burrows; later play became common. In August it was difficult to distinguish juveniles from adults behaviorally.

Colony organization was based on site attachment in forms of "core monopolization" by each individual, "individual arena territory" by males during the breeding season, and "nidic territory" by perinatal females around nest burrows. The colony was further organized around family groups, 11 in 1966, six in 1967 and five in 1968.

Annual activity cycle was 8.5 months (February-October), although no individual was active over 5 months. Daily colony activity during the first and last 3 months was unimodal, around the hot midday hours.

Home range sizes and utilization varied among age and sex classes. Mean home range area in hectares was larger for juveniles (1.2 male and 1.1 female) than for 1-year olds (0.5 male and female) or older animals (0.9 male and 1.9 female). One-year olds showed a varied pattern of home range location and extension in relation to their home ranges the previous year as pups. Home range areas were not used uniformly. Juveniles used moro burrow openings (12.5 male and 14.0 female) than one year olds (7.0 male and 6.0 female) or ages unknown (4.0 male and 7.3 female). Colony expansion through dispersal by young occurred in late summer.

The colony fluctuated from 11 to 67 members; 120 were marked over the 3 years. Densities averaged 0.5/hectare (range 0.1 to 0.9); mean sex ratio was 1.0 male-0.9 female. Only one male lived to 3 years and two females lived to 2 years. A 10 percent population loss occurred between June and October 1966, a 59 percent loss over winter 1966-67, and plague destroyed over 85 percent in 1967. Immigration and emigration were important; distances emigrated were 0.4 and 2.7 kilometer for two males.

A wide variety of vertebrates occur sympatically with the prairie dogs: golden eagles, red-tailed, ferruginous, and marsh hawks, badgers, coyotes, pronghorns and cattle. Richardson's and thirteen-lined ground squirrels inhabit the prairie dog colony and some competition probably occurs.

Throughout descriptions of *C. leucurus*, comparisons are made with related species and taxa where possible. *Cynomys* phylogeny is discussed; varying degrees of adaptation to specific environments has clearly occurred as prairie dogs radiated and filled their current niche-habitats. There appears to be a range in social organization and behavioral complexity among prairie dog species which seems to be strongly correlated with ecological factors (i.e., environmental productivity and seasonality, habitat structure, and predators). (abstract)

30. ———. 1977. Ecology and ethology of the white-tailed prairie dog (*Cynomys leucurus*). Milwaukee public Museum Publications in Biology and Geology No. 3, 97 pp.

This report presents results of a 3-year (1966-1968) field study of the ecology and ethology of a colony of white-tailed prairie dogs on Hutton Lake National Wildlife Refuge, Albany County, Wyoming. The study centered on a 13.2 hectare colony, where all burrow openings on a grid were individually marked. Prairie dogs were live-trapped and marked with toe-clipping and dye. Animals were observed from two elevated blinds located near each end of the colony.

Habitat structure of the colony was investigated by examining vegetation and burrows. The life form of colony vegetation was nearly 90 percent short grasses and forbs, the remainder consisting of mid-grasses, forbs and shrubs.

Basic behavior patterns and organization of the colony were described. Home range sizes were expressed in two ways. Population trends, emigration and immigration were discussed. (synopsis)

31. ———. 1979. The hard life of the prairie dog. National Geographic 156(2):270-281.

Life history, behavior, and extermination, of the white-tailed and black-tailed prairie dog are shown by discussing the yearly life cycle of a dogtown. A plea is made to set aside dogtowns to save prairie dogs from extinction.

32. ———, T. M. Campbell III, D. C. Socha, and D. E. Casey. 1982. Prairie dog colony attributes and associated vertebrate species. Great Basin Nat. 42(4):572-582.

A survey of colony attributes and associated vertebrates on black-tail (*Cynomys ludovicianus*), Gunnison's (*C. gunnisoni*), and white-tail (*C. leucurus*) prairie dogs was made. A belt transect 1.6 kilometer wide and 13,334 kilometer long from Hobbs, New Mexico, to the Utah-Wyoming state line was surveyed. There were 47 colonies located (4760 hectare comprising 2.2 percent) in the belt. Intercolony distances varied significantly. Three black-tail towns averaged 33 hectare in area (SD=26, range 10-61), 11 Gunnison's averaged 46 hectare (SD=43, range 16-150), and 33 white-tail towns averaged 125 hectare (SD=200, range 0.2-958). Badger activity was positively and significantly correlated to colony size and number of burrow openings on Gunnison s and white-tail towns. There were 107 vertebrate species and subspecies (1 amphibian, 25 reptiles, 51 birds, 30 mammals) observed on prairie dog colonies. Results of our surveys are compared with prairie dog studies elsewhere. The role of prairie dogs and relationships to some vertebrates species are discussed.

33. ———, L. Richardson, S. C. Forrest, T. M. Campbell III, D. E. Casey and K. A. Fagerstone. 1985. Black-footed ferret prey base. pp. 7.1-7.14 *in* Black-Footed Ferret Workshop Proc. (S. H. Anderson and D. B. Inkley, eds.), Laramie, Wyoming, Sept. 18-19, 1984.

Ferrets are associated with prairie dogs and eat them as well as other small mammals, birds and insects. Ferret-prairie dog (predator-prey) computer models by Stromberg, et al. (1983) and Powell, et al. (in press) are reviewed. The Meeteese prairie dog complex totals about 3,000 hectares in 33 colonies. Maximum prairie dog density measured was 9.3/hectare and this population has experienced "crashes." In Big Horn Basin, where the ferrets occur, about 250 colonies have been mapped (40,485 hectares) with 90 percent of the Basin surveyed for ferrets (about 1.7 percent is in prairie dogs). About 21 percent of Wyoming has been mapped for prairie dogs (mean colony size=95 hectares; n=924); an estimated 6,000 colonies exist. Prairie dog data has implication for ferret recovery. Ferrets should be transplanted via a captive breeding program immediately to prairie dog complexes meeting minimal viable ferret population requirements as described by Forrest, et al. (in press) and Houston and Clark (in press). (abstract)

34. Collins, A. R., et al. 1982. An economic analysis of prairie dog control. Soc. Range Mgmt. Annu. Meeting 35:10.

35. ____, J. P. Workman, and D. W. Uresk. 1984. An economic analysis of black-tailed prairie dog (*Cynomys ludovicianus*) control. J. Range. Mgmt. 37(4):358-361.

Black-tailed prairie dog (*Cynomys ludovicianus*) control by poisoning with zinc phosphide was not economically feasible in the Conata Basin of South Dakota. Economic analyses were conducted from U.S. Forest Service and rancher viewpoints. Control programs were analyzed with annual maintenance or complete retreatment of initially treated areas to prevent prairie dog repopulation and, except for annual maintenance at low repopulation rates, were unable to recover initial control costs. At a prairie dog repopulation rate of 30 percent per year (the most realistic projection), prairie dog control was not economically feasible and annual maintenance control costs were greater than the annual value of forage gained. Control benefit was forage gained on treated areas. With an increase of approximately 51 kilograms/hectare of cattle forage, over 7 hectares of initial prairie dog control were required to gain 1 AUM per year for the life of the treatment. (abstract)

36. Conley, M., and W. Conley. 1984. Spatial patterns, vegetational associations, and regional status of prairie dog (*Cynomys ludovicianus*) colonies in the Tularosa Basin, New Mexico. New Mexico Dept. of Game and Fish, submitted by New Mexico State Univ., Dept. of Biology and Computing Research Laboratory, Las Cruces, 5 pp.

Three research emphases are explored which are relevant to assessing feasibility of ferret reintroduction. These are (1) investigation of the use of LANDSAT photos and a computerized pattern recognition process to determine regional distributions of *Cynomys ludovicianus* in the Tularosa Basin, (2) concurrent to colony identification activities, burrow marking and burrow dispersion analyses for a sample of the colonies located will be conducted, and (3) line intercept measurements for identification of plant species compositions and cover estimation within and surrounding colonies. (synopsis)

37. Coppock, D. L. 1980. Bison-prairie dog-plant interactions in a northern mixed-grass prairie. Bull. Ecol. Soc. Amer. 61:113.

A grazing interaction is proposed as an important element in the association of bison (*Bison bison*) with prairie dog (*Cynomys ludovicianus*) colonies in Wind Cave National Park, South Dakota. Long- (12 years) and short-term (<3 years) prairie dog occupation decreased total plant standing-crops by 66 percent and 58 percent, respectively. While the vegetative composition of uncolonized and recently colonized sites consisted of 87 percent graminoids and 13 percent forbs, long-term prairie dog impact shifted representation to 53 percent forbs and 47 percent graminoids. Bison strongly selected for recently colonized dog-town margins ($p \leq 0.005$), and while there, grazed more per unit time than on either off-town or older colony sites ($p \leq 0.12$). Short-term prairie dog impact enhances the grazing environment or bison by increasing forage nitrogen-concentration and forage accessibility.

38. ____. 1981. Impacts of black-tailed prairie dogs on vegetation in Wind Cave National Park. M.S. Thesis, Colorado State Univ., Ft. Collins, 86 pp.

39. ____, J. K. Detling, and M. I. Dyer. 1980. Interactions among bison, prairie dogs and vegetation in Wind Cave National Park. Final Report to National Park Service, Wind Cave National Park, Hot Springs, South Dakota, 177 pp.

Studies were conducted during the 1978 and 1979 growing seasons to examine how bison utilized prairie dog towns in the mixed-grass prairie of Wind Cave National Park, South Dakota. Objectives included: (1) quantifying the effects of prairie dogs on the standing crops, composition, and forage quality of vegetation, (2) characterizing seasonal trends in bison visitation to prairie dog towns, and (3) contrasting behavior patterns of bison on and off prairie dog towns.

Prairie dogs decreased peak standing-crops of total (live plus standing dead) vegetation an average of 54 percent at the initially modified edges of dog towns, and an average of 62 percent in the older core areas of dog towns compared to adjacent, off-town prairie. Changes in the overall composition of vegetation relative to off-town prairie were only evident in the core areas of dog towns, however, where the biomass ratios of graminoids:forbs were greatly decreased. Increasing duration of prairie dog impact progressively reduced the litter (mulch) layer and progressively increased the proportion of total live vegetation (relative to standing dead) in the community compared to off-town prairie. This latter trend contributed to dog towns generally having a much greener appearance than off-town grassland, particularly evident at dog town edges. Plants collected from the core areas and edges of dog towns had consistently higher concentrations of crude protein (increases over 20 percent) and had higher percent values for in vitro digestibility (+10 percent) compared to conspecifics collected from adjacent, off-town sites.

Prairie dog towns were visited by bison throughout the growing season, and during the summer dog towns ranked as one of the most-utilized habitats by bison on a park-wide basis. Compared to bison observed on off-town prairie, bison occupying the denuded core areas of dog towns engaged in significantly more breeding-related ($p \leq 0.05$) and resting ($p \leq 0.08$) activities, while grazing was clearly reduced ($p \leq 0.05$). Bison exerted the greatest selection for moderately impacted sites near dog town margins, however, where the grazing intensity of bison exceeded estimates for animals on off-town ($p \leq 0.04$) or colony core sites ($p \leq 0.01$). We concluded that long-term impacts of prairie dogs in centers of dog towns encouraged rutting and resting activity in bison, while short-term impacts at dog town margins encouraged bison grazing. The reductions in obstructive, standing-dead vegetation and the increased forage quality at dog town edges may have been important factors that attracted bison to feed in these areas.

Although this report documents some of the positive aspects of prairie dog impact in relation to bison utilization, there were no conclusions that should preclude the implementation of a wise management plan for prairie dogs in the Park. Theoretical and management implications of the bison-prairie dog interaction are discussed, and recommendations for further research are presented.

40. _____, J. K. Detling, J. E. Ellis, and M. I. Dyer. 1983. Plant-herbivore interactions in a North American mixed-grass prairie; I. Effects of black-tailed prairie dogs on intraseasonal aboveground plant biomass and nutrient dynamics and plant species diversity. Oecologia 56:1-9.

Research was conducted to determine the effects of a native, sedentary rodent of North American grasslands, the black-tailed prairie dog (*Cynomys ludovicianus*), on seasonal aboveground plant biomass and nutrient dynamics and plant species diversity. The study was done on a northern mixed-grass prairie site at Wind Cave National park, South Dakota. (abstract)

41. _____, J. F. Ellis, J. K. Detling, and M. I. Dyer. 1983. Plant-herbivore interactions in a North American mixed-grass prairie; II. Responses of bison to modification of vegetation by prairie dogs. Oecologia 56:10-15.

Studies were conducted during the 1979 growing season to examine how North American bison (*Bison bison*) use prairie dog (*Cynomys ludovicianus*) colonies in Wind Cave National park, South Dakota. Objectives included (1) determining whether bison selected for prairie dog towns parkwide; (2) characterizing in greater detail bison use patterns of a 36-hectare colony in Pringle Valley as a function of time since prairie dog colonization; and (3) relating these bison use patterns to measured changes in structure and nutritional value of vegetation on and off the dog town.

During midsummer, prairie dog towns were one of the most frequently used habitats by bison parkwide. Day-long observations at Pringle Valley revealed that bison exerted strong selection (nearly 90 percent of all habitat use and feeding time) for the dog town, which occupied only 39 percent of the valley. While there, they partitioned their use of the colony by grazing in moderately affected areas (occupied <8 years by prairie dogs) and by resting in the oldest area (<26 years occupation).

Prairie dogs facilitate bison habitat selection for a short-grass successional stage in this mixed-grass community by causing a broad array of compositional, structural, and nutritional changes in the vegetation. (summary)

42. Crocker-Bedford, D. C. 1976. Food interactions between Utah prairie dogs and cattle. M.S. Thesis, Utah State Univ., Logan, 131 pp.

This study examined the food interactions between Utah prairie dogs (*Cynomys parvidens*, Allen) and cattle (*Bos taurus*). During 1974 and 1975, three prairie dog colonies near Panguitch, Utah, were studied intensely: "Oldfield" was chosen to represent colonies near fields of alfalfa (*Medicago sativa*); "Lowercrested" was chosen to represent colonies below 2,200 meters above sea level (a.s.l.) which were not near alfalfa, and "Uppercrested" was chosen to represent colonies above 2,200 a.s.l. which have been planted with crested wheatgrass.

Visual observations were made of Utah prairie dogs to determine their diets. Livetrapping of prairie dogs provided data for estimates of population sizes and animal weights, which were used to calculate forage requirements. Cattle diets and forage intake per individual were derived from the literature.

Much more forage was available to prairie dogs than to cattle. About 80 percent of the forb phytomass ingested by prairie dogs at Uppercrested never would have become available to cattle. Prairie dogs foraged more selectively than cattle are capable of doing. Neither animal showed a general dietary preference toward either grasses or forbs: each plant life form contained both preferred and avoided species. Both animals had a low preference for shrubs.

Oldfield's area tripled between 1971 and 1974, but Uppercrested did not expand. Between June 1, 1974, and June 1, 1975, Oldfield's population increased from about 42 to 70 adult prairie dogs, and the colony's area increased proportionately; however, Uppercrested's population appeared to decline from approximately 22 to 19 adults. The dissimilar expansion rates, at least between 1974 and 1975, probably were due to differences in behavior, forage availability, nutrition, and predation.

Oldfield's prairie dogs gained weight much faster than did Uppercrested's animals. Thus, the average number of active Utah prairie dogs ingesting as much forage as a cow and calf from March through October (prairie dogs fed little during other months) was 410 at Oldfield, compared to 500 at Uppercrested. Numbers concerning total utilization may be even higher: prairie dogs waste little vegetation, but cattle probably trample much. On the other hand, prairie dogs clip closer to the ground and earlier in the growth season than do cattle; consequently, prairie dogs may cause a greater reduction in primary production for the same amount of forage intake.

Population densities of prairie dogs in late June, one month after the young first emerged, were 35/hectare at Oldfield, 16/hectare at Lowercrested, and less than 2.3/hectare at Uppercrested. Prairie dogs used over 70 percent of the primary production of perennial herbage at Oldfield and about 10 percent of it at Lowercrested. Uppercrosted's prairie dogs used approximately 3 percent of the primary production of crested wheatgrass, a preferred forage. Within any one year, cattle probably rarely reduce populations of Utah prairie dogs, and possibly may increase populations in colonies with high primary production.

Prairie dogs apparently have reduced the primary production of perennial herbage at both Oldfield and Lowercrested. Vegetational canopy coverage was greater on mounds than off mounds in the low use portion of Uppercrested. Heavy grazing by livestock in the past probably has eliminated much Utah prairie dog habitat: swales have been destroyed and early spring forage has been reduced.

43. _____, and J. J. Spillett. 1977. Home ranges of Utah prairie dogs. J. Mamm. 58(4):672-673.

Utah prairie dogs (*Cynomys parvidens*) on a 17-hectare study site 2 kilometers north of the Bryce Canyon Airport, Utah, were live-trapped, ear-tagged and dye-marked. From June through August 1974, observed positions were plotted on a grid to determine individual home ranges. The polygon formed by the outermost observations for each individual defined the home range of that individual.

Home ranges were elongate. The home range lengths and areas of three adult males were, respectively, 630, 380, and

370 meters and 8.2, 3.0, and 2.8 hectares. The home ranges of seven adult females averaged 270 meters in length (±51 SD, range 220-350 meters) and 2.3 hectares in area (±1.3 SD, range 1.2-4.5 hectares).

Utah prairie dogs show a close phylogenetic relationship to white-tailed prairie dogs (*C. leucurus*).

During summer, most Utah prairie dogs ranged daily almost the entire lengths of their elongate home ranges, though they did not always cover daily the widths of their ranges. Each range had one end in the well-drained, central area of the ward under study. This 2.8 hectare central area had contained all parturition burrows.

Probably Utah prairie dogs commonly exist with sparser resources than do the other species cited.

The confinement near parturition burrows until mid-June may have been due to two possible causes—sufficient resources until then; and/or some reproductive behavior, such as defense of reproductive territories.

44. ——, and J. J. Spillett. 1981. Habitat relationships of the Utah prairie dog. U.S.D.A., Forest Service Intermountain Region, Ogden, Utah, 29 pp.

The Utah prairie dog (*Cynomys parvidens*, Allen) inhabits five southcentral Utah counties and presently is considered as a species in danger of becoming extinct (U.S. Fish and Wildlife Service, 1977). Utah prairie dog colonies are of three types: (1) High elevation (above 2,200 meters or 7,200 feet), (2) low elevation (below 2,200 meters)(Collier 1975), and (3) low elevation associated with alfalfa.

Two representative Utah prairie dog colonies—a high elevation colony (HC) near the Bryce Canyon airport and a low elevation colony associated with alfalfa (AC) near the junction of Utah Highway 12 and the Sevier River—were intensively studied between February 1974 and September 1975. Comparative data also were collected at a low elevation colony lacking alfalfa (LC) near Hatch.

Aspects studied included the Utah prairie dog's life history, food preferences, and habitat relationships. The species' effects upon vegetation also were evaluated, and recommendations pertinent to the selection of prairie dogs transplant sites and habitat management were developed.

Visually observed chewing times, along with the amounts of aboveground nonwoody biomass, showed that the order of food preference for Utah prairie dogs was cicada insects, alfalfa, grasses, forbs other than alfalfa, shrubs, and then dead vegetation. Plant parts ranked as follows: flowers and seeds, young leaves, old leaves, then stems.

Prairie dogs in HC consistently weighed less ($p<0.01$), gained weight most slowly ($p<0.01$), and ingested less food than those in AC. Prairie dog densities on June 28 were 2.3/hectare in HC, 16/hectare in LC, and 36/hectare in AC (0.9, 6.5, and 14.6/acre). HC did not increase in area nor population, whereas AC expanded rapidly. More alfalfa, more cool season palatable forage, lower elevation, and less predation result in greater body weight, population density, and expansion rate.

Prairie dogs reduced the potential aboveground biomass of grasses and forbs, including alfalfa, by 2 percent at HC, by 10 percent at LC, and by 90 percent at AC. Stunted growth accounted for most of the reduction at AC. Although prairie dogs at low densities may induce positive range trends, at high densities they cause a downward trend in perennial grasses and forbs.

Since 1870, much habitat of Utah prairie dogs has been lost to farms, houses, gullies, and vegetational shifts. Basic habitat requirements for the Utah prairie dogs include deep and well-drained soil, vegetation that prairie dogs can see over or through, and suitable forage. Except at low elevations, suitable forage always includes cool season grasses near the parturition burrows. Also, moist palatable forage must be available throughout the summer. (abstract)

45. Collier, G. D. 1975. The Utah prairie dog: abundance, distribution, and habitat requirements. Ph.D. Dissert., Utah State Univ., Logan, 96 pp.

Objectives of this study were: (1) to determine the status of the Utah prairie dog (*Cynomys parividens*, Allen), a rare mammal endemic to southcentral Utah, and (2) to identify habitat factors which limit densities for this species. Seven components of the habitat were studied: barriers, other animals, soil, temperature and precipitation, topography, vegetation, and water. Prior to collection of habitat data, virtually all populations of the species were found by extensive searching and interviewing; the number of animals and the area occupied were determined for each population.

Results justified the endangered status of the Utah prairie dog. Area occupied by this prairie dog was reduced by an estimated 87 percent during the past 50 years. During this time, the animals disappeared from 34 localities. Recently, total numbers also were reduced: between 1970 and 1971, the total population dropped from an estimated 8,600 animals to 5,700. Only 48 substantial populations existed in 1971. Six other populations were exterminated the preceding year by rodent control.

Although the loss of prairie dogs between 1970 and 1972 resulted from rodent control, another loss between 1971 and 1972 resulted from drought. A drought decimated all populations in regions without water. Topographic region, which reflected water available to plants, was more strongly correlated to density of this prairie dog than any other parameter ($r=.67$).

The crucial role of water was confirmed by analysis of vegetative parameters. Since grasses, forbs, and shrubs have distinctive water contents, they indicated prairie dog response to plant water. Forb cover, which contains the highest relative water content, was the only type of cover that was positively correlated to the density of these animals. Shrubs, with the lowest water content, were negatively correlated; and grasses, with an intermediate water content, were neutral relative to density.

Two other parameters also demonstrated the critical nature of water: the mean number of grasses, forbs, and shrubs, and heterogeneity among plant communities. No other parameters were significant ($p<.05$) in a multiple regression. Together, these explained 75 percent of the variability in abundance of the Utah prairie dog. The mean number of grasses, forbs, and shrubs was negatively correlated with density; coefficients of this parameter probably reflected the time required for prairie dogs to select plant parts with adequate water. On the other hand, heterogeneity among plant communities was positively correlated to density, and indicated emergency sources of plant water. Such water probably allowed prairie dogs to avoid population

reductions otherwise associated with drought.

The critical nature of plant water is especially meaningful in light of long-range drying trends. The Utah prairie dog's habitat has become progressively drier during the past several thousand years. If these trends continue, the animal may become extinct. However, their possible extinction can be delayed by transplanting animals to sites adjacent to streams or irrigated fields. Transplanting also can help solve the secondary problem of rodent control. Since prairie dogs are often eradicated on private lands, transplant sites should be controlled by the public. Public lands in southern Utah usually contain little water; therefore, purchase of certain private lands with adequate water for the animals is a key to managing this unique prairie dog. (abstract)

46. _____, and J. J. Spillett. 1973. The Utah prairie dog—decline of a legend. Utah Science 34:83-87.

This report summarizes findings of a 3-year study of the Utah prairie dog (*Cynomys parvidens*). The population declined 62 percent between 1970 and 1972. The present population trend indicates that it will be extinct before the turn of the century. Poisoning has rapidly influenced the distribution and abundance, although disease has had some effect. (summary)

47. _____, and J. J. Spillett. 1975. Factors influencing the distribution of the Utah prairie dog, *Cynomys parvidens* (Sciuridae). Southwestern Nat. 20(2):151-158.

An evaluation and synthesis of factors which restrict the distribution of the Utah prairie dog (*Cynomys parvidens*) are presented. Four highly important factors are: climate, vegetation, poisoning, and topography. Two factors appear to have been geologically important: climatic changes and interspecific competition. It is hypothesized that the Utah prairie dog occupied large segments of the Great Basin in post glacial times, although expansion into what is now central Utah probably was halted by interspecific competition. Recently the species' range has been reduced in the western portion as a result of drying trends and invasion of shrubby vegetation. Poisoning has been the most operative recent factor; it has caused constriction of the species' range by approximately 50 percent during the past 50 years. (abstract)

48. Dalsted, K. J., S. Sather-Blair, H. K. Worcester, and R. Klukas. 1981.

Application of remote sensing to prairie dog management. J. Range. Mgmt. 34(3):218-223.

The areal extent of prairie dog towns in Wind Cave National park (WCNP) has increased at an alarming rate in the past 20 years. An inventory method was needed to replace the time and labor intensive ground survey method, i.e. rod and transit. Color infrared (CIR) aerial photography (1,370 meters above ground) provided a useful product for rapidly and accurately delineating prairie dog towns. Extent was determined by measurements on the CIR film to be 608 hectares or 5.3 percent of the total WCNP area. Ground measurements, taken near the time of the aircraft overflight, included general vegetation description of each prairie dog town and a vegetation sampling from 0.25 meters plot on a stratified, random basis. The ground data helped explain and identify the variations recorded on the CIR film. Soil and topographic information were used with the CIR film to determine likely expansion potential and probable direction of growth of the 11 major prairie dog towns in WCNP. The prairie dog town inventory and expansion potential of each town has probable usefulness in the development of management plans.

49. Detling, J. K., and E. L. Painter. 1983. Defoliation responses of western wheatgrass populations with diverse histories of prairie dog grazing. Oecologia 57(1-2):65-71.

Photosynthesis and regrowth were compared over a 10-day period following defoliation of about 75 percent of the tillers of western wheatgrass (*Agropyron smithii*) plants collected from a black-tailed prairie dog (*Cynomys ludovicianus*) town and a grazing exclosure at Wind Cave National Park, South Dakota. Prior to defoliation, dog town plants had more tillers, but fewer leaves per tiller, shorter and narrower leaf blades, more horizontal leaves, and higher leaf blade/leaf sheath ratios than plants from the grazing exclosure. Rates of net photosynthesis (PN) did not differ significantly among plants of the two populations, either prior to or following defoliation. From days 2 to 10 following defoliation, PN of remaining undamaged leaves averaged 104 percent of predefoliation rates while PN of similar leaves on non-defoliated plants declined steadily with time, averaging only 79 percent predefoliation rates during this period. Following defoliation, transpiration rates followed similar trends to CO exchange, and rates did not differ between plants of the two populations. Absolute rates of leaf elongation and shoot production were greater in plants from the exclosure. However, defoliation of plants from the exclosure population resulted in a 20 percent reduction in their cumulative shoot dry weight, while cumulative shoot dry weight of plants from the prairie dog town was not significantly affected by defoliation. This apparent ability of plants from the prairie dog town population to withstand defoliation better than plants from the exclosure was attributed to factors such as the higher leaf blade/leaf sheath ratio and more horizontal leaf angles of plants from the former population.

50. Egoscue, H. J. 1975. Abnormal juvenile pelages and estivation in the Utah prairie dog, *Cynomys parvidens*. Southwestern Nat. 20(1):133-136.

The abnormally colored juvenile pelages of *Cynomys* and their subsequent replacement by normal adult fur as reported herein is apparently unique. On 13 May 1973, four young one-fourth grown were noted above ground for the first time. All appeared white in color. Upon closer examination, their eyes were black and their pelage had a slightly grayish cast. Young post-juvenile pelage bore no resemblance to adults and lacked any trace of the blackish-brown eyebrow and cheek markings. The second molt resulted in fur identical to freshly renewed adult summer pelage. The semi-arid nature of much of the habitat occupied by the Utah prairie dog would favor the evolvement of mechanisms by them to evade heat, drought and summer food shortages similar to those of the Townsend and Mohave ground squir-

rels. Field studies are needed to corroborate my findings in captive animals. (synopsis)

51. _____. 1975. The care, management and display of prairie dogs *Cynomys* spp. International Zoo Yearbook 15:45-48.

This report offers suggestions for managing prairie dogs in outdoor enclosures on a sustained-yield basis and calls attention to some educational possibilities for prairie dog exhibits. (summary)

52. _____, and E. S. Frank. 1984. Burrowing and denning habits of a captive colony of the Utah prairie dog. Great Basin Nat. 44:495-498.

Burrows, hibernaculums, and nests of an exhibit colony of the Utah prairie dog, *Cynomys parvidens*, are described.

53. Elias, D. J., J. K. Cier, and H. P. Tietjen. 1974. A technique for capturing prairie dogs. Southwestern Nat. 18:473-474.

The technique utilizes a 550-gallon water tank mounted on a 1.5-ton stake truck and a high sudsing, cold water, liquid detergent. Two men are needed for the operation. One directs the water, gravity-fed through a simple hose, into the burrow and slowly pours the detergent into the stream of water. This is continued until soapsuds rise to the surface. Generally, prairie dogs will emerge shortly after the suds reach the surface. The second man catches the emerging animals with a noose and places them in a holding cage on the truck. The detergent vastly reduces the amount of water required, so many more burrows can be treated with each tankful. The animals are not harmed by this method.

54. Elmore, S. W., and G. W. Workman. 1976. A baseline study of the past and present status of the Utah prairie dog (*Cynomys parvidens*) in Bryce Canyon National Park. Dept. Wildlife Science, Utah State Univ., Logan, 40 pp.

At one time, large colonies of the Utah prairie dog (*Cynomys parvidens*) were very common in the Bryce Canyon National Park area of Utah. Today there are no native prairie dogs residing within the park boundary, although one colony does reside a few miles north of the main entrance to the park.

During the summers of 1974 and 1975, attempts were made to reestablish the Utah prairie dog within the Bryce Canyon National Park boundary. These animals were provided by the Utah Division of Wildlife Resources. The new animals were transplanted in artificial burrows made with a soil auger. Some food was also provided at each site. Daily observations were made at each transplant site to evaluate prairie dog activity, migration from the area, and factors which might influence their ability to survive.

In addition to the above activities, an inventory of suitable transplant sites within the park was made. This also included documentation of previous prairie dog colony sites within the Park.

55. _____, and G. W. Workman. 1977. Status of the Utah prairie dog in Bryce Canyon National Park. Encyclia 54(1):44-45.

56. _____, and C. W. Workman. 1977. Repopulating Bryce Canyon. Utah Science 38(3):79-81.

57. Fagerstone, K. A. 1979. Food habits of the black-tailed prairie dog (*Cynomys ludovicianus*). M.A. Thesis, Univ. Colo., Boulder, 161 pp.

Stomach contents of 158 black-tailed prairie dogs (*Cynomys ludovicianus*) were studied to (1) correlate prairie dog diet with forage availability, (2) determine seasonal variation in prairie dog diet, and (3) determine whether or not prairie dogs avoided feeding on plants possessing the C4-dicarboxylic acid pathway of photosynthesis. Field work was conducted on the eastern one-half of the Buffalo Gap National Grasslands, South Dakota. For each prairie dog collected, the vegetation was measured to determine the percentage of each plant species present in the habitat. Reference slides were prepared and the C3- or C4-photosynthetic pathway was determined for each plant species. Plant species in prairie dog stomachs were identified by comparing their epidermal patterns with the epidermal patterns of reference plant species. Keys were prepared to help in the identification of stomach contents. Statistical tests were used to determine plant preferences, similarity between the habitat and diet, and changes which occurred in the diet throughout the year.

Many plant species were consumed according to their availability. The dominant plant species in both the habitat and diet were wheatgrass, buffalograss and blue grama. Grasses formed the dominant part of the diet throughout the spring, summer, fall and early winter and composed 71 percent of the yearly diet. In January and February, grass consumption decreased and plains prickly-pear was the dominant dietary species; plains prickly-pear composed 57.8 percent of the diet in February. Cactus consumption was probably an adaptation to water stress.

Plant phenology was important in determining prairie dog diet. Plant species normally were eaten during the period when they commenced growth. Cool season grass species were eaten in the spring while some forb species were eaten as they emerged later in the summer. Prairie dogs mostly consumed leaves in the spring, then switched to consumption of stems and roots in the fall and early winter.

Prairie dogs did not avoid C4 species. Instead, C4 grass species were eaten throughout most of the year; blue grama and buffalograss were the most important C4 species in the diet. A seasonal trend was present in the consumption of C3 and C4 species. More C3 species were consumed in the spring and more C4 species were consumed in the fall. The percentage of C4 species in the habitat was higher than predicted for South Dakota by other researchers. There may be two explanations for this: (1) C4 species require less water than C3 species, and prairie dog colonies are sites of limited water availability, or (2) the study area was heavily grazed, and most C4 species increase with heavy grazing pressure.

58. ———. 1981. A review of prairie dog diet and its variability among animals and colonies pp. 178-184 *in* Proc. Fifth Great Plains Wildlife Damage Control Workshop (R. M. Timm and R. J. Johnson, eds.). Institute of Agriculture and Natural Resources, Univ. Nebraska, Lincoln.

After almost 70 years of decline, prairie dog numbers are increasing in many western states. As populations expand, it becomes increasingly important to clarify the degree of competition between prairie dogs and livestock. A review of studies on prairie dog food habits shows variable results. Prairie dogs frequently eat the same plant species as cattle and their activities may cause a decrease in grasses normally considered good livestock forage and an increase in forb cover. However, in some instances, prairie dogs may be beneficial to rangeland; plant species diversity and protein content of forage are often greater on prairie dog colonies than off. It is important to assess each area of prairie dog-cattle interaction separately because prairie dog diet (and competition with cattle) can be extremely variable among geographical areas, colonies, and even animals within colonies. (abstract)

59. ———, H. P. Tietjen, and G. K. LaVoie. 1977. Effects of range treatment with 2,4D on prairie dog diet. J. Range. Mgmt. 30(1):57-60.

Two established prairie dog colonies in Montana were studied to determine the effect of range treatment with 2,4D on prairie dogs' diet. One colony was sprayed with 2,4D for 2 consecutive years and the other was not treated. There was a significant reduction in foliar cover by forbs and shrubs on the treated colony but no change on the untreated colony. Foliar cover by grass did not change significantly on either area. Prairie dog diet changed significantly from forbs to grass after forb coverage was reduced. Before spraying, prairie dogs ate 73 percent forbs and 5 percent grass. Afterward, they ate 9 percent forbs and 82 percent grass. The availability of these foods appeared to be responsible for the diet change. Despite the change in diet, the 2,4D treatment appeared to have little detrimental effect on prairie dogs. They remained in good condition after treatment, as indicated by body weight, and there was no significant difference in prairie dog activity between the treated and untreated colonies. There was considerable variation in diet between the two colonies the first year, with the prairie dogs preferring grass in the untreated colony and forbs in the treated colony. However, in later years preference values were higher for grass than for forbs on both colonies. (summary)

60. ———, H. P. Tietjen, and O. Williams. 1981. Seasonal variation in the diet of black-tail prairie dogs. J. Mamm. 62:820-824.

The relationship between seasonal variation in diets of black-tailed prairie dogs and forage availability was investigated. Prairie dog stomachs were collected from Conata Basin of Buffalo Gap National Grassland, South Dakota and analyzed. Prairie dogs were opportunistic feeders, but plant phenology influenced selection. Prairie dogs selected growing rather than mature plants. Seasonal use of various species is described.

61. ———, and O. Williams. 1982. Use of C3 and C4 plants by black-tailed prairie dogs. J. Mamm. 63(2):328-331.

Prairie dog use of C3 and C4 plants were investigated in Buffalo Gap National Grasslands, South Dakota using prairie dog stomach content analysis. Plants were identified as either C3 or C4 species by straining with potassium iodide. Prairie dogs showed a slight group preference for C4 species. As C3 grasses matured and became less digestible in late summer, prairie dogs avoided them in preference for the increasingly abundant and, at that time, more digestible and more protein rich C4 grasses.

62. Fisher, H. 1982. War on the dog towns. Defenders 57(5):9-12.

Pushed by ranchers, the National Park Service is poised for poisoning prairie dog towns in Wind Cave Park in South Dakota. (synopsis)

63. Fitzgerald, J. P., and R. R. Lechlcitner. 1974. Observations on the biology of Gunnison's prairie dog in central Colorado. Amer. Midland Nat. 92(1):146-163.

A study was conducted from July 1965 to September 1966 on the biology of Gunnison's prairie dog (*Cynomys gunnisoni gunnisoni*) in South Park, Park County, Colorado. Prairie dogs within the colony were loosely organized into clans with adult females playing the major role in caring for the young and warning of danger. Clan boundaries were not patrolled or defended by clan members, but individual burrows, burrow systems or food supplies were protected by individual animals. Little aggression was observed within the clans but members of different clans would engage in disputes when they encountered each other in the common feeding areas. Females had a high ratio of successful pregnancies or uterine implantation sites, but mortality caused by a plague (*Yersinia pestis*) epizootic resulted in the extinction of the main study colony by the spring of 1967. Mean weights of adult males were significantly higher than weights of adult females. Weights of pups increased during the first summer so that by September a few individuals were as large as smaller adults. Immigration and emigration were not important in the colony and the only known successful predators were badgers and red-tailed hawks. Tactile, visual and vocal communication was important in the colony, but in general social behavior was not as well developed as in black-tailed prairie dogs. Prairie dogs were diurnal with two periods of maximum surface activity. Gunnison's prairie dogs completely terminated surface activity for 7 months during the cold season of the year, with pups being the last animals to hibernate. Gunnison's prairie dogs did not work or shape their mounds and their activity had little visible impact on their environment. Most of the time the animals spent aboveground was occupied in eating or searching for food. Grasses were the preferred foods but a variety of forbs were also utilized. (abstract)

64. Flath, D. L. 1979. Status of the white-tailed prairie dog in Montana. Proc. Montana Acad. Sci. 38:63-67.

The Montana range of the white-tailed prairie dog (*Cynomys leucurus*) is precisely described. The status of the colonies, mortalilty factors and population recruitment are discussed. (abstract)

65. ———, and R. K. Paulick. 1979. Mound characteristics of white-tailed prairie dog maternity burrows. Amer. Midland Nat. 102:395-398.

Mound size characteristics of 682 white-tailed prairie dog (*Cynomys leucurus*) burrows were examined in Carbon County, Montana. Burrows containing litters had significantly larger mounds than those which did not. Mounds of litter-occupied burrows contained accessory digging for 48 of 49 observed litters. Maternity burrows can be identified by size and presence of current accessory digging.

66. Foltz, D. W., and J. L. Hoogland. 1981. Analysis of the mating system in the black-tailed prairie dog (*Cynomys ludovicianus*) by likelihood of paternity. J. Masss. 60:706-712.

Black-tailed prairie dogs (*Cynomys ludovicianus*) live in colonies composed of contiguous but separate groups called coteries. A coterie usually contains one or two adult males, one to six adult females, and several yearlings and juveniles. For 50 of 52 litters produced by 46 females in 1979 and 1980, an electrophoretic analysis of four blood proteins indicated that the litter was fathered by one of the males in the home coterie. For 14 of 18 litters produced in coteries containing more than one adult male, paternity could be unambiguously assigned to one of the resident males. These results indicate that coteries, originally defined as units of social structure, are also units of reproduction.

67. ———, and J. L. Hoogland. 1983. Genetic evidence of outbreeding in the black-tailed prairie dog (*Cynomys ludovicianus*). Evolution 37(2):273-281.

The genetic structure of the black-tailed prairie dog (*Cynomys ludovicianus*) was studied by an electrophoretic analysis of four polymorphic blood proteins and by pedigree analysis. Only one probable case of close inbreeding (father-daughter) was observed in a 3-year period; the average inbreeding coefficient was less than that expected if matings were at random. The evidence for nonrandom mating was consistent with behavioral observations taken at the main study colony. In 9 of 11 instances, polymorphic loci exhibited an excess of heterozygotes (that is, negative fixation indices). The existence of locus-specific differences among fixation indices suggested that some factor in addition to the avoidance of close inbreeding was causing the excess of heterozygotes. Two possible explanations for this result are selective differences among genotypes and sex-related allele frequency differences. Additional evidence for outbreeding in the black-tailed prairie dog is (a) the relatively high heterozygosity within colonies, (b) the relatively low genetic heterogeneity among colonies and (c) the high rate of male migration among colonies.

68. Foreman, D. 1981. Follicular dynamics in a monestrous annually breeding mammal, the prairie dog (*Cynomys ludovicianus*). Pp. 245-251 *in* Dynamics of ovarian function (N. B. Schwartz and M. Hunzicker-Dunn, eds.). Raven Press, New York.

69. ———, and D. Garris. 1984. Plasma progesterone levels and corpus luteum morphology in the female prairie dog (*Cynomys ludovicianus*). Gen. Comp. Endocrinol. 55(2):315-322.

Plasma progesterone levels in female prairie dogs were determined by a radioimmunoassay specific for progesterone. Plasma progesterone levels were determined in samples taken before estrous, at estrous, during the luteal phase, and during anestrus from females maintained all year in the laboratory. Progesterone levels were also determined in plasma samples taken in the laboratory from two pregnant and three postparturient females captured in the field. Progesterone levels were low before estrous and continued low during estrous. They rose on the first week after estrous to 0.8 ng/ml or above and continued at or above this level for 9 to 14 weeks following estrous. Gestation in prairie dogs is 35 days in this species. Progesterone levels of three postparturient females were above 1.0 ng/ml for 7 weeks after their arrival in the laboratory. These females all had uterine scars showing that they had delivered their litters before they were captured. Two females were determined to be pregnant at the time of their capture. These females later reabsorbed their fetuses (determined by laparotomy). Progesterone values of samples from these females were all above 1.0 ng/ml except for one low value in one female which occurred 3 weeks after her capture and after reabsorption of her fetuses was in progress. The cells of the corpus lutea (CL) of nonpregnant, pregnant, and postparturient females had well-developed rings of cytoplasmic basophilia but as the CL regressed this pattern became disorganized and disappeared. The function of this basophilia is not known. The long luteal phase found in female prairie dogs is compared to those found in other species of mammals. This is the first annually breeding rodent reported to have a longer luteal phase than the period of gestation.

70. French, N. R., W. E. Grant, W. Grodzinski, and D. M. Swift. 1976. Small mammal energetics in grassland ecosystems. Ecol. Monogr. 46(2):201-220.

71. Gadi, A., and R. K. Plakke. 1977. Renal anatomy of the black-tailed prairie dog (*Cynomys ludovicianus*). J. Colorado-Wyoming Acad. Sci. 9/1):45-46.

The renal anatomy of the black-tailed prairie dog (*Cynomys ludovicianus*) is described with special emphasis on those structures assocrated with the ability of mammals to produce a highly hypertonic urine.

The kidney of the black-tailed prairie dog is unilobar with a prominent papilla and well defined inner and outer medullary zones. The mean absolute and relative dimensions of the kidney are as follows: kidney size, 14.1 millimeters; absolute cortical thickness, 2.9 millimeters; absolute medullary thickness, 10.5 millimeters; relative cortical thickness, 2.1 millimeters; relative medullary thickness 7.3 millimeters. The vascular architecture of the medulla indicates well developed vasa recta and vascular zonation correlated with inner

and outer medullary zones. The vascular trees of the cortex most closely resemble the pattern described for the cat. The pelvis exhibits well developed fornices which project into the outer medullary creating secondary pyramids.

These data indicate that this species possesses all of those renal structural features which are proposed to contribute to the ability to produce a significantly hypertonic urine.

72. Garrett, M. G. 1982. Dispersal of black-tailed prairie dogs in Wind Cave National Park, South Dakota. M.S. Thesis, Iowa State Univ., Ames, 76 pp.

73. ____, and W. L. Franklin. 1981. Prairie dog dispersal in Wind Cave National Park: possibilities for control. Pp. 185-198 in Proc. Fifth Great Plains Wildlife Damage Control Workshop (R. M. Timm and R. J. Johnson, eds.). Institute of Agriculture and Natural Resources, Univ. Nebraska, Lincoln.

A study was conducted in Wind Cave National Park, South Dakota, to collect basic information on black-tailed prairie dog (*Cynomys ludovicianus*) dispersal and to test alternative control techniques. Dispersal occurred during a limited time period in late spring, involved both male and female prairie dogs, and resulted in relatively short movements and poor survivorship. The use of artificial visual barriers to inhibit colony expansion was effective but difficult to apply. The use of diethylstilbestrol as a temporary antifertility agent was shown to be an easy and effective method to reduce prairie dog reproduction and decrease colony expansion. (abstract)

74. ____, J. L. Hoogland, and W. L. Franklin. 1982. Demographic differences between an old and a new colony of black-tailed prairie dogs (*Cynomys ludovicianus*) Amer. Midland Nat. 108:(1):51-59.

Two colonies of black-tailed prairie dogs (*Cynomys ludovicianus*) in Wind Cave National Park, South Dakota, were compared during 1979 and 1980 to investigate the effects of (1) the age of the population and (2) the availability of resources on specific demographic parameters. The younger colony was surrounded by, and expanding into, unused available habitat. The older colony had little available habitat for expansion. At the younger colony (1) there was a greater proportion of successful pregnancies; (2) the litters were larger; (3) the juveniles grew faster; (4) yearlings were more likely to reproduce; (5) survivorship of adults and juveniles was greater, and (6) the density was more than 2 times that of the older colony. Individuals at the younger colony showed a distinct feeding preference for vegetation growing at the colony periphery. Because this peripheral vegetation had only recently been modified from surplus habitat, we hypothesize that surplus habitat available to the younger colony accounted for the observed demographic differences. (abstract)

75. ____, and W. L. Franklin. 1983. Diethylstilbestrol as a temporary chemosterilant to control black-tailed prairie dog populations. J. Range Mgmt. 36:753-756.

Controlling reproduction in pest rodent populations may be preferable to using lethal rodenticides. The effectiveness of diethylstilbestrol (DES), a synthetic estrogen, as a reproductive inhibitor in female black-tailed prairie dogs (*Cynomys ludovicianus*) was examined in a 4-year study at Wind Cave National Park, South Dakota. In 1979 and 1980, a study colony was monitored to determine age structure, reproductive success of individual animals, and rate of colony expansion. In 1981, the colony was divided into control and experimental areas. Application of DES-treated oats (.11 percent active ingredient) during the breeding season resulted in complete curtailment of reproduction in the experimental group while reproduction in the control group was normal. Results were identical in 1982 when treatment was reversed. There were no obvious effects of DES treatment on subsequent reproductive capability of study animals. In 1981, surface expansion of the study colony was 4 times less on the DES-treated side compared with control.

76. Gold, I. K. 1976. Effects of black-tail prairie dog mounds on shortgrass vegetation. M.S. Thesis, Colorado State Univ., Ft. Collins, 40 pp.

Aboveground plant species biomass surrounding black-tail prairie dog burrows in northeastern Colorado was measured. Significant differences for the influence of prairie dog mounds were observed for aboveground biomass of certain plant species on a native short-grass prairie dogtown and an adjacent oldfield dogtown. The difference in mound construction of dome-shaped and crater-shaped mounds contributed to differences in aboveground biomass of certain plant species.

Plant species diversity and total aboveground biomass increased with distance from the burrows. Some grass species had lower biomass within 10 meters of the burrows because of the prairie dog mound influence. Plant species probably favored by soil disturbance from the mounds and decreased competition from other plants exhibited greater amounts of biomass closer to the burrows. (abstract)

77. Gunderson, H. L. 1978. Under and around a prairie dog town. Nat. Hist. 87(8):56-67.

This popular article tells about prairie dog social behavior and habitat relationships. It focuses on relations with humans, predators, and climate.

78. Hamilton, J. D., and E. W. Pfeiffer. 1977. Effects of cold exposure on renal function in black-tailed prairie dogs. J. Applied Physiol: Respirat. Eviron. Exercise Physiol. 42:295-299.

Black-tailed prairie dogs (*Cynomys ludovicianus*) were deprived of food and water for several weeks during the fall and winter in a cold-room hibernaculum (T 5-8 C), and for several days at room temperature during the summer. Body temperatures (T) were determined periodically in nine animals by radiotransmitters implanted in the abdomen. Animals deprived of food and water in the summer were killed when maximum urine concentration was achieved. Eight animals in the winter were active when killed after 7 to 35 days in the hibernaculum with T between 18 and 36 C. Five animals that became torpid periodically in the winter were killed after 19 to 42 days in the hibernaculum when

their T indicated torpor (T<13 C). Active animals in the summer and winter possessed pronounced renal corticomedullary urea and sodium concentration gradients. Torpid animals lacked these gradients and had lower urine and plasma osmotic concentrations than active animals. Plasma urea values and terminal osmolal U/P ratios were lowest in torpid prairie dogs.

79. Hansen, O. J. 1977. Taxonomic status of the prairie dog subspecies *Cynomys ludovicianus ludovicianus Ord* and *Cynomys ludovicianus arizonensis* Mearns. M.S. Thesis, Eastern New Mexico Univ., Portales.

Cynomys ludovicianus arizonensis is distinguished from *Cynomys ludovicianus ludovicianus* by size of mastoid breadth. That character shows a zone of intergradation between the two subspecies.

While examining the status of the two subspecies of *Cynomys ludovicianus* in New Mexico, a distinct population of that species was found in the Tularosa Basin. The population, which is partially isolated from other prairie dogs by physical features on the north, east, and west and by a Creosote Desert Association on the south, is being declared a new subspecies on the basis of size of cranial depth and pelage reflectance.

80. Hansen, R. M., and B. R. Cavender. 1973. Food intake and digestion by black-tailed prairie dogs under laboratory conditions. Acta Theriol. 18:191-200.

Four consecutive laboratory feeding trials were made on subadult prairie dogs, *Cynomys ludovicianus Ord*, 1817. Food intake averaged 4.1 to 0.14 grams and live weight gain 0.88 to 0.09 grams per 100 grams of body weight per day in the earliest test and decreased to 2.3 to 0.14 and 0.02 to 0.07 per grams of body weight per day (respectively) in the last test. There was a significant increase in the percent apparent digestion of organic matter (84.5 to 87.2), gross energy (84.3 to 87.0), and dry matter (81.6 to 84.3) from the first to the last feeding period. There was no difference in the apparent digestion of minerals and nutrients by male and female prairie dogs when computed on an equal live weight basis. Males (X=945 grams) consumed more energy per day because they averaged 120 grams heavier than females (X=825 grams). The mean live weight of all prairie dogs was 782 grams at start and was 988 grams at the end of the study.

81. ____, and I. K. Gold. 1977. Black-tail prairie dogs, desert cottontails and cattle trophic relations on shortgrass range. J. Range. Mgmt. 30(3):210-214.

The trophic relations among black-tail prairie dogs, desert cottontails, and cattle were determined among three dogtowns at the Central Plains Experimental Range near Nunn, Colorado. Sedges were the most important food of prairie dogs and cottontails and the second most important food of cattle on an annual basis. There was a high percentage similarity in the diets of the three herbivores studied; and they consumed large percentages of sedges and grass. The amount of aboveground herbage eaten and made unavailable because of soil disturbances by prairie dogs and cottontails was about 24 percent of the total potential annual production. (abstract)

82. Hassien, F. 1976. Prairie dog bibliography. U.S. Dept. Interior, B.L.M., Technical Note 279, 28 pp.

This bibliography lists 437 references dealing with prairie dogs. Some references do not specifically mention prairie dogs but involve closely related topics and are considered important enough for inclusion. Entries have been categorized according to major subjects. (synopsis)

83. ____. 1976. A search for black-footed ferrets in the Oklahoma panhandle and adjacent area and an ecological study of black-tailed prairie dogs in Texas County, Oklahoma. M.S. Thesis, Oklahoma State Univ., Stillwater, 111 pp.

Black-footed ferrets were not found by the investigator in the study area. Reports, and the numerous ferret-like signs found, indicate that a small population of black-footed ferrets may still exist in the study area.

A minimum of 123 prairie dog towns were present in Texas County, Oklahoma. The average size of 85 of these towns was 14 hectares. *Buchloe dactyloides* was an increaser on four of the five towns studies. Taller species of vegetation were reduced or eliminated on the towns. Prairie dogs significantly increased four soil chemicals in the upper 12 centimeters of soil on the towns. Prairie dogs decreased range condition of sandy soil in relatively good condition, but simultaneously increased litter and vegetation ground cover on these range sites. Range livestock management decisions concerning prairie dogs should also consider the interrelationships of prairie dog density, range sites, range condition, and livestock use on prairie dog towns. (synopsis)

84. Henderson, R. F. 1973. Controlling problem prairie dogs. Coop. Ext. Serv., Pub. L-350 Rev., Kansas State Univ., Manhattan, Leaflet 7 pp.

This pamphlet discusses nonpoisoning methods and the poison grain method for prairie dog control. (synopsis)

85. Hillman, C. N., R. L. Linder, and R. B. Dahlgren. 1979. Prairie dog (*Cynomys ludovicianus*) distribution in areas inhabited by black-footed ferrets (*Mustela nigripes*). Amer. Midland Nat. 102:185-187.

The distribution of black-tailed prairie dog (*Cynomys ludovicianus*) towns was delineated in a 1490-kilometer study area in Mellette County, South Dakota, and was examined to determine the characteristics of black-footed ferret (*Mustela nigripes*) habitat. Between 1964 and 1974, black-footed ferrets were observed on 14 prairie dog towns in this area. Eighty-six prairie dog towns, located throughout the study area, were not randomly distributed; towns were paired or clumped in spatial distribution. Mean distance between a town and its nearest neighbor was 2.3 kilometers; mean distance between a ferret-occupied town and the nearest town was similar, 2.7 kilometers. Management recommendations are to maintain at least eight towns per town-

ship, each at least 12 hectares in size. Of these eight towns, two or more should exceed 40 hectares. (abstract)

86. Hlavachick, B. D., and G. P. Snell. 1981. Biological control of prairie dogs in southcentral Kansas. Soc. Range. Mgmt. Ann. Meeting 34:19.

87. Hoogland, J. L. 1977. The evolution of coloniality in white-tailed and black-tailed prairie dogs. Ph.D. Dissert., Univ. Michigan, Ann Arhor, 292 pp.

In a 3-year study, the costs and benefits of coloniality in two species of squirrels (Sciuridae) were investigated; loosely colonial white-tailed prairie dogs (*Cynomys leucurus*) and densely colonial black-tailed prairie dogs (*C. ludovicianus*) were also investigated. White-tail study sites were in Wyoming and Colorado. Black-tail study sites were in Colorado and South Dakota. The results of the investigation are organized into three chapters.

In Chapter 1, four possible costs of prairie dog coloniality were examined: (1) increased competition, (2) increased transmission of ectoparasites, (3) increased probability of misdirected parental care because of mixing-up of unrelated young, and (4) increased conspicuousness. For both white-tails and black-tails, competition correlated positively with ward (subcolony) size; it could not be determined if black-tail competition was more severe than white-tail competition. Flea infestation within burrows correlated positively with colony size for both white-tails and black-tails. Further, both burrow and animal counts indicated that ectoparasitism was more severe for black-tails than for white-tails. Though white-tail and black-tail young both mingled with unrelated young soon after their first emergence from the natal burrows, there appeared to be little disadvantage associated with such mixing for parents of either species.

In Chapters 2 and 3, three hypotheses which might explain the evolution of prairie dog coloniality were examined: (1) shortage of suitable habitat, (2) social facilitation of foraging, and (3) decreased predation. Nearest-neighbor breeding synchronization among black-tails and the absence of solitary individuals of either species indicated that there was no shortage of suitable habitat. A detailed analysis of black-tail foraging strategies indicated that there was probably no social facilitation of foraging in terms of either (a) group-hunting, (b) location of large, scattered food supplies, (c) modification of the soil in order to effect the growth of vegetation more favorable and/or more abundant than that which would otherwise result, or (d) group-defense of feeding areas. Predation defenses were studied by using a stuffed badger (*Taxidea taxus*) and by monitoring individual alertness. For both white-tails and black-tails, data from simulated badger attacks showed significant positive correlations between ward size and (a) earliness of the first visual alarm, (b) earliness of the first vocal alarm, (c) the number of available visual alarms, (d) the number of available vocal alarms, and (e) selfish herd effects; further, there were significant negative correlations between ward size and (f) the proportion of ward residents responding in alert and (g) the proportion of residents giving vocal alarms. Data from these same experiments indicated that black-tails are probably better protected than white-tails against surprise predatory attacks. Regarding individual alertness of adults, (a) residents of large wards were less watchful than residents of smaller wards for both white-tails and black-tails, (b) black-tails were less watchful than white-tails, and (c) individual black-tails at ward peripheries were more wary than individuals at ward centers.

88. ———. 1979. Aggression, ectoparasitism, and other possible costs of prairie dog (Sciuridae, *Cynomys* spp.) coloniality. Behavior LXIX 1-2:1-35.

In a 4-year study, the costs of coloniality for two species of squirrels (Sciuridae) were investigated: loosely colonial white-tailed prairie dogs (*Cynomys leucurus*) and densely colonial black-tailed prairie dogs (*C. ludovicianus*). By an examination of both intra- and interspecific effects, four costs were investigated: (1) increased aggression, (2) increased transmission of diseases and ectoparasites, (3) increased probability of misdirected parental care resulting from the mixing of unrelated young, and (4) increased conspicuousness to predators. The possibility of various miscellaneous costs was also investigated.

In summary, there are probably several costs associated with prairie dog coloniality, that the severity of some of the costs correlates positively with colony or ward size for both white-tails and black-tails, and that some of the costs are probably more pronounced for black-tails than for white-tails. (synopsis)

89. ———1979. The effect of colony size on individual alertness of priaire dogs (Sciuridae: *Cynomys* spp.). Anim. Behav. 27:394:407

From 1974 to 1976, individual alertness of two species of squirrels (Sciuridae) were examined: loosely colonial white-tailed prairie dogs (*Cynomys leucurus*) and densely colonial black-tailed prairie dogs (*C. ludovicianus*). By observing single adults for 30-min periods and recording various measures of alertness, the effects on individual alertness of four variables based on data from 188 white-tail observations and 280 black-tail observations. Individual alertness consistently correlated negatively with effective increases in ward size and ward density. The study includes various hypotheses that might explain these negative correlations, and conclude that decreased individual alertness is an important benefit of priarie dog coloniality. (abstract)

90. ———, 1981. The evolution of coloniality in white-tailed and black-tailed prairie dogs (Sciuridae:- *Cynomys leucurus* and *C. ludovicianus*). Ecology 62(1):252-272.

In a 6-year study, possible selective bases for coloniality in two species of squirrels (Sciuridae) were investigated:- loosely colonial white-tailed prairie dogs (*Cynomys leucurus*) and densely colonial black-tailed prairie dogs (*C. ludovicianus*). White-tail study sites were in Wyoming and Colorado. Black-tail study sites were in Colorado and South Dakota. Three hypotheses that might explain the evolution of coloniality were examined: (a) shortage of suitable habitat, (b) social facilitation of foraging, and (c) reduced predation. The apparent surplus of unused suitable habitat and the absence of isolated individuals both indicated that prairie dogs are not forced to live together because of habitat shortages. An analysis of prairie foraging patterns indicated that there is no social facilitation of foraging in terms

of either (a) group hunting of either large or elusive prey (b) the location of large, scattered food supplies, (c) modification of soil in order to effect the growth of vegetation that is more favorable or more abuntant than that which would otherwise result, or (d) group defense of foraging grounds. Three lines of evidence indicate that reduced predation may be the most important benefit of prairie dog coloniality. First simulated predatory attacks by badgers (*Taxidea taxus*) indicated that individuals in large wards (subcolonies) detect preditors more quickly than do individuals in smaller wards; further, black-tails detect preditors more quickly than do white-tails. Second, individuals in large wards devote proportionately less time to alertness (i.e., scanning for predators) than do individuals in smaller wards, and black-tails are less vigilant than are white-tails. Third, breeding synchronization and center-edge differences in individual alertness both indicate the possible importance of selfish herd effects. Interspecific differences in ward size and ward density may ultimately result because white-tail habitats contain significantly more protective cover than do black-tail habitats. (abstract)

91. _____. 1981. Nepotism and cooperative breeding in the black-tailed prairie dog (Sciuridae: *Cynomys ludovicianus*). Pp. 283-310 in Natural Selection and Social Behavior (R. D. Alexander and D. W. Tinkle, eds.). Chiron, New York.

In 1976-1978, the social behavior of a cooperatively breeding squirrel, the black-tailed prairie dog (Sciuridae: *Cynomys ludovicianus*) was investigated. A female black-tail usually remains in her natal coterie territory from birth until death. By contrast, a male usually remains in his natal coterie territory only during his first year and disperses sometime during his second year. Thus, adult females (2 years old) and yearlings of both sexes within a coterie are usually close genetic relatives. Behavioral interactions (fights, chases, allo-grooming, etc.) indicate that adult females, adult males, and yearlings are all nepotistic. For both sexes, individuals with close genetic relatives in the home coterie are more likely to give an alarm call during a predatory attack than are individuals without such nearby relatives. Two variations in social organization ("split" and "double" coteries) further emphasize the importance of nepotism. Annual reproductive success of adult males probably does not increase directly with coterie size. Contrary to expectation, annual reproductive success of females varies inversely with coterie size. Several possible explanations for the latter inverse relationship are discussed.

92. _____. 1982. Prairie dogs avoid extreme inbreeding. Science 215:1639-1641.

Black-tailed prairie dogs (Rodentia: Sciuridae: *Cynomys ludovicianus*) live in colonies composed of contiguous but separate family groups called coteries. During the 6 years that individuals in a colony were observed, they almost never mated with close genetic relatives. Inbreeding is avoided in four ways: (i) a young male usually leaves his natal coterie before breeding, but his female relatives remain; (ii) an adult male usually leaves his breeding coterie before his daughters mature, (iii) a young female is less likely to come into estrous if her father is in her coterie; and (iv) an estrous female behaviorally avoids mating with a father, son, or brother in her coterie. (abstract)

93. _____. 1983. Black-tailed prairie dog, *Cynomys ludovicianus*, coteries are cooperatively breeding units. Amer. Nat. 121:275-280.

Black-tailed prairie dogs live in polygymnous social groups called coteries which typically contain one adult male, three to four genetically related adult females, and several yearling and juvenile offspring of the adult females. Hoogland argues that black-tails can legitimately be designated as cooperative breeders. When compared to helping and competition within the social units of other cooperatively breeding species, helping within the black-tail coterie may be less extreme and competition with the coterie may be more extreme. Thus, black-tails should probably be ranked at the lower extreme in the continuum of cooperative breeders.

94. _____. 1983. Nepotism and alarm calling in the black-tailed prairie dog. Anim. Behav. 31(2):472-479.

At a colony containing 200 individuals of known ages and genetic relationships, I investigated alarm calling by black-tailed prairie dogs (Rodentia: Sciuridae: *Cynomys ludovicianus*) during experiments with a stuffed specimen of a natural predator, the badger (*Taxidea taxus*). As in other species of burrowing squirrels, female alarm calls are evidently nepotistic (i.e. function to warn genetic relatives). Male alarm calls are also nepotistic, and individual males vary their rate of alarm calling in response to the presence or absence of close genetic relatives in the home territory. Beneficiaries of alarm calls in other species of squirrels usually include adult or juvenile offspring, but beneficiaries of black-tailed prairie dog alarm calls frequently include only non-descendant kin.

95. _____, and C. R. Gustavson. 1980. Manipulation of wheat and oat preferences in black-tailed prairie dogs: a field demonstration using methiocarb as a taste aversion agent. Prairie Nat. 12(3&4):114-118.

96. _____, and D. W. Foltz. 1982. Variance in male and female reproductive success in a harem-polygynous mammal, the black-tailed prairie dog (Sciuridae: *Cynomys ludovicianus*). Behav. Ecol. Sociobiol.

Black-tailed prairie dogs are colonial rodents that live in contiguous social groups called coteries. A typical coterie contains one adult (>2 years old) male, three or four adult females, and several yearlings and juveniles of both sexes. A large coterie sometimes contains two or more adult males. Using detailed behavioral observations on 164 females (of which 160 copulated) and data from four polymorphic loci from parents and offspring of 121 litters, we examined the black-tail mating system.

Most females (101/164=62 percent) copulated with a single adult male, and only 3 of the 102 litters with >2 offspring (3 percent) showed unequivocal evidence of multiple paternity.

Adult males usually copulated with several different adult females.

In one-male coteries, females usually copulated exclusively with the resident adult male (RAM) (82/112=73 percent); this trend was confirmed by electrophoresis of blood samples. In multimale coteries, each female frequently copulated with at least two different RAMs (28/52=54 percent); in 4 of 5 multimale coteries (80 percent) which produced two or more litters whose paternities could be unequivocally resolved by electrophoresis, two different RAMs each sired at least one litter.

Of the 164 females, 30 (18 percent) copulated with both the RAM (or one of the RAMs, in multimale coteries) and an extracoterie adult male, but only 3 (2 percent) copulated exclusively with an extracoterie adult male. Electrophoresis showed that 9 of 121 litters (7 percent) were sired by an extracoterie adult male.

Intersexual comparisons of annual reproductive success and lifetime reproductive success both indicate that blacktails are polygynous (i.e., that variance in reproductive success is greater for males than for females). (abstract)

97. Hyde, R. M. 1981. Prairie dogs and their influence on rangeland and livestock. Pp. 202-206 *in* Proc. Fifth Great Plains Wildlife Damage Control Workshop (R. M. Timm and R. J. Johnson, eds.). Institute of Agriculture and Natural Resources, Univ. Nebraska, Lincoln.

Scientific and popular literature is cited to question the shortgrass disclimax theory. (synopsis)

98. Ingham, R. E., and J. K. Detling. 1983. Effects of grazing by prairie dogs and bison on soil nematode populations in a northern mixed grass prairie. Soc. Range Mgmt. Annu. Meeting. 36:12.

99. Jameson, W. C. 1973. On the eradication of the prairie dog—a point of view. BioScience 44(3):129-135.

100. Jones, T., and R. Plakke. 1981. Histology and histochemistry of the perianal scent gland of the black-tailed prairie dog (*Cynomys ludovicianus*). J. Mamm. 62(2):362-368.

The black-tailed prairie dog (*Cynomys ludovicianus*) possesses a trilobate perianal scent gland. The gland is located between the internal and external sphincter muscles of the rectum. Two of the lobes lie ventro-laterally to the rectal canal while the remaining lobe lies ventral to the canal. Each lobe is connected to the rectal lumen by its own duct. The lobes are kidney shaped and measure approximately six by three by three millimeters. Each lobe contains an epithelial lined reservoir, an apocrine and a holocrine element. Both glandular elements are connected to the reservoir by a series of ducts. Conventional histochemical staining techniques were employed to determine the nature of the secretary products of these glands during the quiescent premating period of September through December. The holocrine elements were PAS negative for carbohydrates while tetrazotized benzidine coupled with betanapthol proved positive for protein. Sudan black B gave positive results for lipids. These lipids were highly non-polar. The presence of phospholipids and cholesterol were ruled out. The apocrine elements lacked secretary vacuoles and were negative to all tests. (abstract)

101. Karami, M. 1981. Epizootiology of plague, and flea exchange between black-tailed prairie dogs and interacting mammals. Ph.D Dissert., Colorado State Univ., Ft. Collins; 141 pp.

The objective of this research was to elucidate mechanisms underlying interspecific flea exchange, which is of great importance in the epizootiology of plague. A black-tailed prairie dog (*Cynomys ludovicianus*) colony on the western outskirts of Fort Collins, and small mammals living adjacent to the colony were studied from October 1979 to September 1980.

Fleas of prairie dogs and nine other mammalian species which were captured in the colony and surrounding areas were collected, identified and listed. Plague organism was isolated from flea pools of wood rats (*Neotoma mexicana*) 500 meters to the west of the colony. Flea pools of *Peromyscus maniculatus* and *Eutamias quadrivittatus* collected by the Center for Disease Control scientists 12 kilometers south of the study area within the time of my study also yielded *Yersinia pestis*. Plague remained confined to the wood rat population, and did not spread to prairie dogs in the study area. Probability of spread of plague by infected and blocked wood rat fleas which were capable of actually transmitting the infection was calculated, and it was concluded that the probability was very low (0.027) for any individual wood rat. It was hypothesized that the disturbed prairie dog-flea complex in the colony, with low flea populations due to flooding of the burrows, was not likely to maintain a plague epizootic even if the bacteria had actually reached the colony. Wood rats were susceptible to the disease and could not act as maintenance host for plague in the study area for a sustained period of time. *Peromyscus maniculatus* was ubiquitous, and was hypothesized to be the most likely maintenance host for plague, although insufficient data were available to support this hypothesis.

Ecologic and behavioral factors including coexistence of the species in the same habitat, relative density of these species, and degree of competition in use of resources were found to be instrumental in interspecific flea exchange and were discussed.

102. Klatt, L. E., and D. Hein. 1978. Vegetative differences among active and abandoned towns of black-tailed prairie dogs (*Cynomys ludovicianus*). J. Range. Mgmt. 31(4):315-317.

Vegetational differences were studied among one active prairie dog (*Cynomys ludovicianus*) town and three towns which had been abandoned 1, 2, and 5 years, respectively. Blue grama (*Bouteloua gracilis*) and buffalograss (*Buchloe dactyloides*) were dominant on all four study areas. Percent cover of total vegetation, grasses, and increaser and invader species declined with length of abandonment. Percent cover of the only decreaser, western wheatgrass (*Agropyron smithii*), was similar on the abandoned towns and lowest on the active town. Composition of vegetation on the four study

areas did not indicate that the usual stages of secondary succession on short grass prairie had occurred on the abandoned prairie dog towns. Most changes in vegetation following abandonment of 5 years or less by prairie dogs were apparently relatively minor and would not benefit cattle grazing significantly. (abstract)

103. Knowles, C. J. 1982. Habitat affinity, populations, and control of black-tailed prairie dogs on the Charles M. Russell National Wildlife Refuge. Ph.D. Dissert., Univ. Montana, Missoula, 171 pp.

Black-tailed prairie dogs (*Cynomys ludovicianus*) were studied from 1978 through 1980 on the Charles M. Russell National Wildlife Refuge, Montana. One hundred twelve (112) prairie dog towns were found; 96 were active and occupied 0.6 percent (2122 hectares) of the refuge, usually on sites with less than 12 percent slope. Most town sites were associated with livestock watering areas and homestead sites. Roads or well-established ungulate trails were found at 109 of the towns. Horizontal visibility and bare ground were significantly greater in towns than adjacent areas, and total plant and grass cover were significantly less in towns. Forb cover was greater in towns but not significantly so. Herbage utilization by prairie dogs was 29 percent by midsummer, and 90 percent by cattle and prairie dogs for the same period.

From 1964 through 1979, 11 towns had a high (r=0.279) initial growth rate followed by a steady decline, approaching equilibrium by 1979. Presently, growth rates are high for towns less than 10 hectares and low for towns 10 hectares and greater. In a small expanding town, mortality and reproductive rates indicated a highly negative growth rate (r=0.434), but increases in numbers were due largely to immigration from a nearby (3 kilometers) large town. Dispersal occurred between mid-May and mid-July. Dispersing dogs were at least 1-year old. Of the 38 dogs observed dispersing, 37 were traveling on roads.

Oats treated with 2 percent zinc phosphide were applied at seven towns using four reduction patterns. Populations reached pre-treatment levels within 2 years after perimeter and split reductions. Another 2 years appeared to be needed to reach pre-treatment numbers in towns receiving total reduction. Center reduction produced intermediate results. (abstract)

104. ———. 1985. Observations on prairie dog dispersal in Montana. Prairie Nat. 17(1):33-40.

Observations were made on prairie dog dispersal on the Charles M. Russell National Wildlife Refuge from 1973 to 1981. Peak dispersal occurred in late May and early June in association with emergence of juveniles. Dispersal included both individuals that moved within prairie dog towns (yearling males) and those that left prairie dog towns to immigrate into a new town or attempt to establish a new town (males and females). Immigration into one 3-hectare prairie dog town located 3 kilometers from a larger town accounted for 42 percent of the adult population in one year. Dispersing prairie dogs were frequently found traveling roads. A high occurrence of prairie dog towns with roads or cattle trails in them on the refuge suggests that roads and trails may facilitate prairie dog dispersal.

105. ———. 1985. Some relationships of black-tailed prairie dogs to livestock grazing. Unpub. manuscript.

Relationships of black-tailed prairie dogs to livestock grazing were studied on the Charles M. Russell National Wildlife Refuge and the Fort Belknap Indian Reservation in northeast Montana. A total of 154 prairie dog town sites was examined and the majority were found to be associated with livestock watering sites and/or areas where the top soil was disturbed by human activity. Roads and cattle trails were found in 150 of the prairie dog towns. In a portion of one study area, prairie dog towns were found to be located significantly closer to livestock water developments and homestead sites than randomly located points. The distribution of observations of cattle in one grazing allotment showed a significantly greater number of cattle observations on quarter sections with prairie dog towns as opposed to quarter sections without prairie dogs towns. Cattle in this allotment were found to primarily graze shrub-grassland habitats and to use slopes of less than 11 degrees. Habitats and topographic situations used by prairie dogs in this allotment corresponded to those most intensively used by cattle. Forage utilization at a prairie dog town in this allotment was estimated at 90 percent by mid-summer. Prairie dogs appeared to have consumed about a third of the vegetation with grasses the predominant forage class used.

106. ———, C. J. Stoner, and S. P. Gieb. 1982. Selective use of black-tailed prairie dog towns by mountain plovers. Condor 84:71-74.

Habitat use by Mountain Plovers (*Charadrius montanus*) was studied in north-central Montana during 1978 and 1979. Mountain Plovers were found to selectively inhabit black-tailed prairie dog (*Cynomys ludovicianus*) towns. Horizontal visibility and bare ground were significantly greater inside prairie dog towns used by plovers than adjacent areas. Total plant cover and grass cover were significantly lower inside prairie dog towns than on adjacent areas. Most towns on the study area were associated with an area that was intensively grazed by cattle. Plovers used only the active towns larger than 3 hectares located on level upland sites (n=16 out of 35). (abstract)

107. ———, and P. R. Knowles. 1984. Additional records of mountain plovers using prairie dog towns in Montana. Prairie Nat. 16:183-186.

A total of 147 mountain plovers was counted on 11 of 42 prairie dog towns during a black-footed ferret survey on the Fort Belknap Indian Reservation in north-central Montana. Prairie dog towns used by mountain plovers were larger ($p<0.001$) than towns where plovers were not observed. Two flightless broods of mountain plovers were observed, establishing a new latilong breeding record for Montana One plover was observed in a fallow wheatfield.

108. Lebsack, G. A. 1983. Newcastle resource area—prairie dog management plan. BLM, New Castle Resource Area, New Castle, Wyoming, 12 pp. plus appendices.

This plan was developed to manage and control black-tailed prairie dogs on public land in the Wyoming portion of the New Castle Resource Area. (synopsis)

109. Lerwick, A. C. 1974. The effects of the black-tailed prairie dog on vegetative composition and their diet in relation to cattle. M.S. Thesis, Colorado State Univ., Ft. Collins, 106 pp.

This study was conducted to describe differences in vegetative composition that may occur between areas exposed to grazing both by cattle and prairie dog and areas grazed only by cattle. A secondary interest was to determine the degree that cattle and prairie dogs compete for forage.

Two active prairie dog towns were used as the study sites. Transects on these sites were located partly inside the town and partly outside in the area adjacent to the town. Data were collected in May, June, August, and September, 1973. Cover, frequency, and standing crop data were collected for plant species and fecal samples of cattle and prairie dogs were collected for dietary analysis.

It was found that prairie dog grazing exerted selective pressure against blue grama (*Bouteloua gracilis*) and favored buffalograss (*Buchloe dactyloides*). Prairie dog activities favored invasion of annuals, but their presence alone did not cause this to happen when other factors were not favorable. Their activities increased the number of both annual and perennial species present. Total cover inside the town increased when annual species were present. When the species present were predominantly perennials total cover was decreased by prairie dogs.

Grasses were the main components of the diets of both cattle and prairie dogs. During a seasonal drought cattle increased their intake of forbs, and prairie dogs depended more heavily on grasses. The favorite species of both cattle and prairie dogs were blue grama, needleleaf sedge (*Carex eleocharis*), sand dropseed (*Sporobolus cryptandrus*) and scarlet globemallow (*Sphaeralcea coccinea*). If anything else was available, neither cattle nor prairie dogs consumed buffalograss, a dominant plant species on both sites. (abstract)

110. Lewis, J. C. 1973. Additional records of black-footed ferrets in Oklahoma. Southwestern Nat. 18(3):350.

The range of the black-tail and Gunnison prairie dogs most likely included the historical geographic range of the black-footed ferret too.

111. ——, E. H. McIlvain, R. McVickers, and B. Peterson. 1979. Techniques used to establish and limit prairie dog towns. Proc. Oklahoma Acad. Sci. 59:27-30.

Techniques used to establish black-tail prairie dog towns are described to assist persons planning to establish such colonies. Prairie dogs were captured in 1973 to 1975 as they exited from burrows flooded by water and detergent. They were placed in holding cages in six 2.5-hectare pastures fenced with poultry wire, held captive for 3 to 12 days, and then permitted to escape. Our goal of 10 prairie dogs overwintering per hectare was reached in winter 1975-76. Prairie dogs that moved to pastures adjacent to the release area were gassed or were repelled by using R-55 and placing visual barriers around burrows. (abstract)

112. Linder, R. L., and C. N. Hillman. 1973. Proceedings of the black-footed ferret and prairie dog workshop. South Dakota State Univ., Brookings, 208 pp.

113. ——, et al. 1978. Black-footed ferret recovery plan. USDI, Fish and Wildlife Service, Washington, D.C., 150 pp.

The Black-footed Ferret (BBF) Recovery Plan outlines actions needed to meet the objective of "maintaining at least one wild self-sustaining population of black-footed ferrets (BBF) in each state within its former range." The plan is general in scope, intended to provide direction to, and increase coordination between, state and federal land management and conservation agencies. There is sufficient flexibility in the plan to permit adjustments within jobs to fit situations and needs that exist in each state. (preface)

114. Lund, G. F. 1974. Time and energy budgets by telemetry of heart rate from free ranging black-tailed prairie dogs in natural and model environments. Ph.D. Dissert., Univ. Iowa, Des Moines, 177 pp.

The principal objectives of this study were to obtain estimates of rates of energy expenditure associated with specific behaviors of free ranging black-tailed prairie dogs (*Cynomys ludovicianus*) and then to partition time and energy for behaviors over 24-hour periods. Comparisons of these partitions were made among five animals (three animals each) in the natural environment and in a model environment (a room) in which conditions of food were altered; hence, behavioral and energetic responses to environmental changes could be followed over several days. Estimates of rates of energy expenditures were predicted from heart rates (recorded by telemetry) from associations between heart rate and oxygen consumption empirically established on each animal by repeated measurements in the laboratory. Mean correlation co-efficients for 23 associations among each of the five animals ranged between 0.911 to 0.946 and could be empirically improved. The associations were stable during rapid changes in variables, for different behaviors and levels of activity, and over time, perhaps at least several days. Characteristic allocations of time and energy by the animals in various environments were noted. In the field, time spent and rates of energy expenditure tended to be inversely related so that energy costs for feeding and total above-ground activity were similar across animals. A relation ($y=0.799x$) between the percents of time (y) and energy (x) per 24 hours spent in feeding was established from data obtained in the model environment (correlation 0.994). Data for the natural environment seem to apply as well. From this relation the total energy expended per day could be closely estimated by measurement of only the average daily rate of energy expenditure per hour for feeding (rate x 0.799 x 24 hours). A mathematical model supported by the data is presented which suggests how organisms respond energetically to environmental changes. This model has relevance to

questions concerning species diversity and ecosystem stability. A versatile receiving antenna to allow field use of small laboratory radio transmitters was designed. The conceptual framework for this study and the application of information on time and energy budgets to ecology as as a research directive toward "Allometrics in Ecological Bioenergetics" are discussed.

115. ——, and G. E. Folk. 1976. Simultaneous measurements of heart rate and oxygen consumption in black-tailed prairie dogs. Comp. Biochem. Physiol. 55:201-206.

Studies were conducted to explore the potential for using telemetry of heart rates as an index of rates of energy expenditures in free-ranging black-tailed prairie dogs (*Cynomys ludovicianus*).

For periods of 1 hour with activities varying spontaneously or by exciting the animal, heart rate and oxygen consumption were highly correlated with coefficients averaging >0.9.

The relationships appeared stable for one to a few days but differed over weeks or longer.

Relative comparisons of costs for behaviors over circadian cycles and a few days would seem feasible by the heart rate index method in prairie dogs. (abstract)

116. Masterson, L., and J. M. Child. 1973. The black-footed ferret—predator in peril. Animal Kingdom, April:8-11.

Government scientists are now studying captive ferrets in an attempt to propagate this rapidly vanishing species. (synopsis)

117. Menkens, G. E., Jr. 1985. Current prairie dog research. Pp. 8.1-8.10 *in* Black-Footed Ferret Workshop Proc. (S. H. Anderson and D. B. Inkley, eds.). Laramie, Wyoming, Sept. 18-19, 1984.

118. Michener, G. R. 1982. Kin identification, matriarchies, and the evolution of sociality in ground-dwelling sciurids. Pp. 528-572 *in* Recent advances in the study of mammalian behavior (J. F. Eisenberg and D. G Kleiman, eds.). Amer. Soc. Mamm. Spec. Publ. 7.

119. ——, and J. 0. Murie. 1983. Black-tailed prairie dog coteries: are they cooperatively breeding units? Amer. Nat. 121:266-274.

120. Murie, J. 0., and G. R. Michener. 1984. Biology of ground dwelling squirrels. Univ. Nebraska Press, Lincoln, 459 pp.

121. National Park Service. 1979. Draft management plan for black-tailed prairie dog: Badlands National Park. 17 pp.

This plan addresses concerns expressed by rancher and farmer neighbors of Badlands National Park about prairie dogs migrating from the national park onto adjacent grazing and agricultural lands. Analysis of the situation indicates the problem prairie dog colonies are located along the north and west boundaries of the national park on recently acquired inholdings that have been disturbed by domestic livestock grazing and farming. (description of proposed action)

122. Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Mgmt. 38:541-545.

123. Nichols, J. B. 1976. Biochemical variations in *Cynomys*. Ph.D. Dissert., Colorado State Univ., Ft. Collins, 145 pp.

The serum and hemoglobin of *Cynomys ludovicianus, C. leucurus,* and *C. gunnisoni* were analyzed by both vertical starch gel and polyacrylamide disc gel electrophoresis. Starch gels were stained for general protein, while polyacrylamide gels were processed in triplicate and stained for general protein, transferrin, and esterases.

Through the starch gel technique, the hemoglobins of the three prairie dog species were found to be of the diffuse (vs. single) phenotype. The possible adaptive advantages of this phenotype were discussed. Polyacrylamide electrophoresis demonstrated that hemoglobin mobility does not differ among species.

Starch gel electrophoresis of serum resolves fewer protein fractions than does the polyacrylamide technique. However, the polymorphic nature of black-tail prairie dog transferin was detected more easily in starch gels than in polyacrylamide gels. The examination of polyacrylamide serum patterns revealed that within species variability was rather low in comparison with several other rodents. Among species, both qualitative and quantitative differences were detected, that are diagnostic at the species level.

A similarity matrix was employed to analyze the relationships among these three prairie dog species, based on their polyacrylamide serum patterns. The resulting classification does not differ from the currently accepted classification. However, the suggestion of some authorability, much of the variability in protein content was attributable to these effects. Protein $1M^2M1$s were generally found to be higher in females than in males, and higher in adults than in pups. The probable reasons for these differences were discussed. Species differences in protein content were also detected. Protein levels were found to be higher in black-tails than in the other two species.

124. ——, and D. J. Nash. 1980. Biochemical variations in three species of prairie dogs (*Cynomys*). Comp. Biochem. Physiol. 65A:155-158.

Blood proteins were studied by polyacrylamide disc gel electrophoresis in three species of prairie dogs, *Cynomys gunnisoni, C. leucurus,* and *C. ludovicianus*. The sera were separated into 13-15 fractions and the three species could be distinguished by both qualitative and quantitative differences in their serum patterns. Qualitatively, variations in the occurrence and number of slow albumin fractions are diagnostic at the species level. Quantitative differences were most apparent in variation in the mobility of the major albumin fraction and the transferrin fraction. (abstract)

125. O'Meilia, M. E. 1980. Competition between prairie dogs and beef cattle for range forage. M.S. Thesis, Oklahoma State Univ , Stillwater, 32 pp.

Competition for range forage between black-tailed prairie dogs (*Cynomys ludovicianus*) and steers was evaluated in terms of the effects prairie dogs have on forage availability, utilization, and steer weight gains. Pastures grazed by steers only were designated control pastures and pastures grazed by prairie dogs and steers were designated treatment pastures. Small mammals and arthropods were monitored to determine if the presence of prairie dogs influence these populations. Prairie dogs decreased forage availability and utilization by cattle during 1977 and 1978. However the influence of prairie dogs on the forage crop did not significantly reduce steer weight gains during either year. It appears highly probable that the presence of prairie dogs may positively influence soil fertility, nutrient recycling, and subsequent forage quality, thus partially compensating for the reduction in forage availability and utilization by steers in prairie dog pastures pastures containing prairie dogs were also found to support a greater biomass of small mammals. Arthropod biomass was more than three times as high in control pastures. (abstract)

126. ____, F. L Knopf, and J. C. Lewis. 1982. Some consequences of competition between prairie dogs and beef cattle. J. Range. Mgmt. 35(5):580-585.

Competition for range herbage between black-tailed prairie dogs (*Cynomys ludovicianus*) and steers was evaluated in terms of the effects prairie dogs have on herbage availability and use, and steer weight gains. Pastures grazed only by steers were termed control pastures and pastures grazed by prairie dogs and steers were designated treatment pastures. Small mammals and arthropods were monitored to determine if prairie dogs influence populations of these animals. Prairie dogs decreased herbage availability, which apparently led to reduced utilization by cattle during 1977 and 1978. The influence of prairie dogs on the herbage crop did not cause a statistically significant reduction in steer weight gains. However, the lower weight gains of treatment steers amounted to market values of $14-$24/steer less than control steers. The presence of prairie dogs appears to improve herbage quality, thus partially compensating the reduction in herbage available to steers. Pastures containing prairie dogs also supported a greater biomass of small mammals. Arthropod (mainly grasshopper) biomass in August was most than three times higher in control pastures than in treatment pastures. (abstract)

127. Owings, D. H , and S. C. Owings. 1979. Snake-directed behavior by black-tailed prairie dogs (*Cynomys ludovicianus*). Z. Tierphychol. 49:35-54

When exposed to an anesthetized snake, feral black-tailed prairie dogs living in a high-snake-density area approached ambivalently and investigated the snake, typically near the head. Snake-investigation was interrupted intermittently, when the prairie dog jumped away, foot thumped or jump yipped, and approached the snake again. This behavior attracted other prairie dogs, who behaved similarly. Message analyses of two apparent signaling acts—foot thumping and jump yipping—demonstrated that they convey information that withdrawal from the snake has become less likely, and continued interaction with the snake more likely. Prairie dogs in a zoo and feral prairie dogs in a low-snake-density area were unresponsive to immobile snakes, but reacted strongly when the snake was permitted to move. We compared these results to similar data on California ground squirrels and discussed the selection pressures and ontogenetic and perceptual processes that may have acted as determinants of this snake-directed behavior. (abstract)

128. Pfaffenberger, G. S , B. Nygren, D. de Bruin, and C. Wilson. 1984. Parasites of the black-tailed prairie dog (*Cynomys ludovicianus*) from eastern New Mexico. Proc. Helminthol. Soc. Washington 51(2):241-244.

129. Pfeiffer, E. W., L. N. Reinking, and J. D. Hamilton. 1979. Some effects of food and water deprivation on metabolism in black-tailed prairie dogs, *Cynomys ludovicianus*. Comp. Biochem. Physiol.

Prairie dogs deprived of food and water at normal room temperatures can survive for long periods (without apparent ill effects after 6 weeks) with weight losses approaching 50 percent. During food and water deprivation during the summer, respiratory exchange ratio drops below 0.7, oxygen consumption decreases, and rectal temperature drops slightly. Unlike winter experimental animals, prairie dogs deprived of food and water in summer became dehydrated and azotemia. Furthermore, plasma triglyceride and ketone concentrations of these animals were much lower than those of winter experimental and control prairie dogs.

Typical mammalian responses to starvation, such as azotemia, hypoglycemia, and ketosis do not develop in winter starved prairie dogs, and their blood chemistry has many characteristics resembling that of black bears in winter sleep. Some possible metabolic adaptions are discussed. Similar concentrations (range: 62-180pg/ml) of aldosterone were found in summer experimental and control prairie dogs. (abstract)

130. Pizzimenti, J. J. 1974. Evolution of the prairie dog genus *Cynomys* (*Rodentia: Sciuridae*). Ph.D. Dissert., Univ. Kansas, Lawrence, 208 pp.

Prairie dogs are colonial rodents closely related to ground squirrels and are endemic to central North America. Five species have been recognized since about 1900, although the status of several species has been questioned in recent years. The primary aim of this study is to clarify the interspecific relationships within the genus *Cynomy*, and to present a model of its evolution.

Chromosomal and electrophoretic data refute the hypothesis of recent gene exchange between *C. leucurus* and *C. gunnisoni*. Data from chromosomes and proteins reveal the Utah prairie dog, *C. parvidens*, to be very closely related to *C. leucurus*. The black-tailed and Mexican prairie dogs, *C. ludovicianus* and *C. mexicanus*, have similar karyotypes but are easily distinguished from *C. leucurus* and *C. parvid-*

ens on the basis of centromere position. Serum transferrins and albumins are also similar in ludovicianus and mexicanus but are easily distinguished from those of the three other species.

The genetic and morphometric data combined with information on ectoparasites and the fossil record suggest that prairie dogs arose from ground squirrel stock in the southern Rocky Mountains during the Pleistocene. Adaptations to xeric environments and lower elevations permitted populations to spread east and west from the mountains and was accompanied by increases in the diploid number. Gradual uplifts of the mountains coupled with climatic changes gradually separated populations on the plains from those in the mountains and the western slopes. *C. parvidens* and *C. mexicanus* are interpreted as relict populations of *C. leucurus* and *C. ludovicianus* respectively. *C. gunnisoni* probably is the most primitive species. Its slow divergence from the ancestral stock may be attributed to montane habitats where steep altitudinal gradients have provided a "shifting refugia" during periods of environmental change.

131. _____. 1975. Evolution of the prairie dog genus *Cynomys*. Occ. Papers Mus. Nat. Hist. No. 37, Univ. Kansas, Lawrence, 73 pp.

This paper is a published version of Pizzimenti's Ph.D. Thesis. See that abstract above.

132. _____. 1976. Genetic divergence and morphological convergence in the prairie dogs, *Cynomys gunnisoni* and *C. leucurus*: 1. Morphological and ecological analyses. Evolution 30(2):345-366.

Data on chromosome and protein variation were gathered for the purpose of assessing present day gene flow and genetic divergence both in and around the zone of contact of these two species in western Colorado. These data are presented in part II of this study and reveal that these species are characterized by distinct gene pools with little or no evidence of introgression, past or present. Regardless of chromosomal or biochemical identity, prairie dogs from the zone of contact had dark pelage and gray-centered tails characteristic of *C. gunnisoni* but were also rather large animals which gave a chatter-like alarm bark characteristic of *C. leucurus*.

Multiple regression analyses show that larger size can be explained in terms of warmer temperatures and greater precipitation as well as lower latitudes. The more southernly environments are characterized by higher productivities, longer growing seasons, and less inclement weather, thus increasing the *Cynomys* energy budget.

Photometric studies reveal brightness of pelage color is highly correlated with the brightness of background (soil) suggesting that coloration is regulated by selection pressures from ground and aerial predators.

This study emphasizes the need to integrate genetic and ecological information into the more classical techniques of analyzing character variation if a true understanding of patterns of morphological variation and their underlying causes is to be attained. (synopsis)

133. _____. 1981. Increasing sexual dimorphism in prairie dogs: evidence for changes during the past century. Southwestern Nat. 26(1):43-47.

Museum samples of prairie dogs (*Cynomys*) collected between 1890 and 1971 show a pattern of increasing sexual dimorphism through time. Recent populations have a larger proportion of significantly dimorphic traits. Increasing size dimorphism, as estimated by cranial length, appears to be the result of greater size increases among males. Two hypotheses, both implicating human disturbance, are presented to explain the phenomenon: (1) increased competition for females (i.e., sexual selection) arising from changes in population structure and (2) differential growth of the sexes in response to changing vegetation and hence dietary regimes. (abstract)

134. _____, and R. S. Hoffman. 1973. *Cynomys gunnisoni*. Mamm. Species No. 25, 4 pp.

The following topics are included context and content, diagnosis, general characters, distribution, fossil record, form, function, ontogeny and reproduction, ecology and behavior and genetics.

135. _____, and L. R. McClenaghan, Jr. 1974. Reproduction, growth, and development and behavior in the Mexican prairie dog, *Cynomys mexicanus* (Merriam). Amer. Midland Nat. 92(1):130-145.

Reproduction of *C. mexicanus* is unique among prairie dogs in that the reproductive season is extremely protracted, and may last for six months. The growth rate is equal to or greater than in other members of the genus. Molting in *C. mexicanus* is complex, involving four or more overlapping phases. Behavior patterns and vocalizations in *C. mexicanus* are most similar to those of *C. ludovicianus*. Alarm barks, chatter barks, growls, screams and elation calls of *C. mexicanus* show varying degrees of similarity to those of *C. ludovicianus*. Considering the rapid development, it is estimated that *C. mexicanus* pups are capable to reproduction during their 1st year. (abstract)

136. _____, and G. D. Collier. 1975. *Cynomys parvidens*. Mamm. Species No. 52, 3 pp.

The following topics are included; context and content, disgnosis, general characters, distribution, fossil record, form, function, ontogeny and reproduction, ecology and behavior and genetics.

137. Player, R. L., and P. J. Urness. 1982. Habitat manipulation for reestablishment of Utah prairie dogs in Capitol Reef National Park. Great Basin Nat. 42(4):517-523

Utah prairie dogs were transplanted onto the site of a former colony, located in Capitol Reef National Park, Utah. Shrubs on the site were significantly taller than those found on active colonies in similar habitat located on the Awapa Plateau. Therefore, the transplant site afforded a test of the hypothesis that shrub height is a major inhibitory factor affecting occupation of sites by prairie dogs. Four sites of 5 hectare each were used. Vegetation treatments- rotobeating, railing, and 2,4-D herbicide were carried out on three of the sites and the fourth was used as a control. Shrub height and percent cover were significantly reduced on all three treatment sites. Posttreatment effects on the vegetation showed

that the greatest percent moisture of the herbage was found on the railed site, followed by the herbicide, rotobeaten, and control sites. Measurements of the visual obstructions to prairie dogs showed the rotobeaten site had the greatest visibility, followed by the railed, herbicide, and control sites.

Prior to release of prairie dogs on the study area, 200 artificial burrows per treatment were dug using a power auger. In early summer, 1979, 200 Utah prairie dogs were live-trapped near Loa, Utah. An equal number by sex and age class were released on each treatment. In 1979 a significantly higher number of animals reestablished on the rotobeaten site. In 1980 and 1981 the rotobeaten and railed sites had significantly higher prairie dog numbers than the other sites. Reproduction occurred on both the rotobeaten and railed sites in 1980 and 1981. Results indicated that when transplanting animals onto sites of former colonies presently overgrown with shrubs, the chance of a successful transplant could be increased by first reducing shrub height and density. (abstract)

138. Potemkin, J. R. 1976. Aggression and territoriality in the Zuni prairie dog, *Cynomys gunnisoni zuniensis*. Amer. Soc. Mamm. 56th Annu. Meeting, Lubbock, Texas.

139. Potter, R. L. 1980. Secondary successional patterns following prairie dog removal on shortgrass range. M.S. Thesis, Colorado State Univ., Ft. Collins, 165 pp.

Small mammal diggings have long interested the ecologist. Prairie dogs produce perhaps the most dramatic changes to the edaphic and biotic environments on the Great Plains of North America. Even though interest in these animals has been growing steadily in the past 30 or so years, quantitative studies of their range relationships are few. Aboveground biomass of plants growing on and around black-tail prairie dog (*Cynomys ludovicianus*) mounds was measured in the early and late summer of 1976, 1977, and 1978 on three different prairie dog towns in eastern Colorado. The first two years' data represent decreasing pressure from prairie dogs on two towns. The 1978 data represent total absence of prairie dogs on two towns. The third town was active in all three years of the study. Differences in plant composition and aboveground biomass production between sampling dates and among years are related to weather pattern, physical soil properties and degree of use by prairie dogs in this thesis. Varying amounts of agreement with traditional concepts of plant succession on shortgrass oldfields and abandoned roads were found. Aboveground biomass increased dramatically on and off mounds following removal of prairie dogs. Most of this increase was due to annual forbs. (abstract)

140. ____, and R. M. Hansen. 1980. Early plant succession following removal of prairie dogs on shortgrass range. Soc. Range Mgmt. Annu. Meeting 33:41.

Small mammal diggings have long interested the ecologist. Prairie dogs produce perhaps the most dramatic changes to the edaphic and biotic environments on the great plains of North America. Even though interest in these animals has steadily been growing in the past 30 or so years, quantitative studies of their range relationships are few. In early and late summer of 1976, 1977, and 1978, above-ground biomass of plants growing on and around black-tail prairie dog mounds was measured on three different prairie dog towns in eastern Colorado. The first two years' data represent decreasing pressure from prairie dogs on two towns. The 1978 data represent total absence of prairie dogs on two towns. The third town was active in all three years of the study. Differences in plant composition and biomass production between sampling dates and years are related to weather pattern, site differences, and degree of use by prairie dogs. Varying amounts of agreement with traditional concepts of plant succession on shortgrass oldfield and abandoned roads were found.

141. Powell, R. A. 1982. Prairie dog coloniality and black-footed ferrets. Ecology 63(6):1967-1968.

These comments discuss Hoogland's (1981) hypothesis about the evolution of coloniality in prairie dogs, concluding that coloniality evolved to reduce predation. He argued that differences in coloniality between white-tailed and black-tailed prairie dogs are due to habitat differences that facilitate different predator avoidance techniques. Hoogland minimized the importance of differences in predation pressure on the two prairie dog species. My own research on energetics of Siberian polecats (*Mustela eversmanni*) fed black-footed ferret diets indicates that ferrets can maintain populations only in prairie dog colonies with 100 reproducing prairie dogs (R.A. Powell, personal observation). This colony size is consistent with Hoogland's data for black-tailed prairie dog colonies but not for most white-tailed prairie dog colonies. Species' range maps of the black-footed ferret, black-tailed prairie dog, and white-tailed prairie dog suggest differences in predation by black-footed ferrets may have been more important than Hoogland concluded. (synopsis)

142. Prairie Dog Control Task Force. 1984. Proposed 5-year plan for a prairie dog control program on the Pine Ridge Indian Reservation. Submitted to John W. Fritz, Deputy Assistant Secretary-Indian Affairs (operations) by Prairie Dog Control Task Force, through the Director, Office of Trust Responsibilities, B.I.A., Washington, D.C., 32 pp.

This is a proposed 5-year plan for prairie dog control on the Pine Ridge Indian Reservation. (synopsis)

143. Randall, D. 1976. Poison the damn prairie dogs! Defenders 51(6):381-383.

This article discusses the U.S. Fish and Wildlife Service's plan to poison black-tailed prairie dogs on the Charles M. Russell National Wildlife Range in Montana. (synopsis)

144. ____. 1976. Shoot the damn prairie dogs! Defenders 51(6):378-381.

This article discusses the rising popularity of varmint hunting and the pressure it is putting on prairie dog populations in Wyoming (synopsis)

145. Raynor, L.S. 1984. Yearling behavior, reproduction, and dispersal in Gunnison's prairie dog. Amer. Zool. 24(3):2A.

Populations of the highly social Gunnison's prairie dog (*Cynomys gunnisoni*) were studied at two sites in southcentral Colorado. The sites differed in availability of water, duration of the growing season, and the diversity and quantity of edible vegetation. At the lusher site (QC), all age-sex classes weighed significantly more than their counterparts at the poorer site (BM). Two of five yearling females raised litters at QC, whereas none of 15 yearling females were sexually mature at BM. At QC 6 of 17 yearlings dispersed from their natal harem, but none of the 31 yearlings at BM dispersed. Dispersal of yearling females was not precipitated by agonistic interactions, but yearling male dispersal resulted from direct conflict with male siblings and resident adult males. These results are an intraspecific test of Armitage's (1981) hypothesis that delayed sexual maturity and dispersal in the large-bodied, social ground squirrels is associated with the age at which juveniles attain adult weight.

146. Record, C. R. 1978. Ground squirrel and prairie dog control in Montana. Paper presented at 8th Vertebrate Pest Conf., Sacramento, California, March, 1978.

The Columbian ground squirrel (*Spermophilus columbianus*), Richardson ground squirrel (*Spermophilus richardsoni*), and black-tail prairie dog (*Cynomys ludovicianus*) cause millions of dollars damage to Montana agriculture each year. Montana's ground squirrel and prairie dog control programs are based upon local organization and operation with technical assistance being provided by the Montana Department of Livestock Vertebrate Pest Control Bureau. The results of field research programs using zinc phosphide, Compound 1080, and strychnine grain baits to control these species are reported. (abstract)

147. Reinking, L. N., D. L. Kilgore, Jr., E. S. Fairbanks, and J. D. Hamilton. 1977. Temperature regulation in normothermic black-tailed prairie dogs, *Cynomys ludovicianus*. Comp. Biochem. Physiol. 57A:161-165.

The relationship between body mass (g) and metabolism in the Family Sciuridae is described by the equation ml 0 /hr = 3.9W which is not statistically different from the standard mammalian relationship (3.8 W). Normothermic black-tailed prairie dogs have a narrow thermal neutral zone. Minimal VO was recorded at temperature of 30.2 C. (VO = 2.6ml 0 /g hr, T = 38.1 C) and was 67 percent of that predicted based on body mass. A circadian cycle in temperature exists with peak mid-day and low nocturnal values. Between temperature of 20 and 30 C, temperature rises yet VO decreases. Changes in conductance may account for hyperthermia during decreased heat output. Above thermal neutrality conductance increases sharply. Heat storage is discussed in terms of its contribution to water balance. (abstract)

148. Roslyn, J., J. E. Thompson Jr., and L. Denbesten. 1979. Anesthesia for prairie dogs. Anim. Sci. 29(4):542-544.

The combination of 20 milligram xylazine/kg of body weight and 100 to 150 milligrams ketamine/kg of body weight provided satisfactory levels of anesthesia in 63 prairie dogs, and the combination was tolerated well with a mortality rate of 3.2 percent. (summary)

149. Schenbeck, G. L. 1981. Management of black-tailed prairie dogs on the National Grasslands. Pp. 207-213 *in* Proc. Fifth Great Plains Wildlife Damage Control Workshop (R. M. Timm and R. J. Johnson, eds.). Institute of Agriculture and Natural Resources, Univ. Nebraska, Lincoln.

Black-tailed prairie dogs (*Cynomys ludovicianus*) occupy approximately 22,800 hectare on 11 National Grasslands in the West. Prairie dog control has been implemented on five National Grasslands and is planned for one additional National Grassland. A unique prairie dog management program in the Conata Basin are of the Buffalo Gap National Grassland is highlighted in this report. Conata Basin is a major prairie dog area and attempts are being made to control prairie dogs while trying to maintain habitat for the black-footed ferret (*Mustela nigripes*). Repopulation of treated colonies has been a major and costly problem in Conata Basin, and it appears that most treated colonies will need retreatment at least every 3 years. (abstract)

150. Schreiber, H. L., W. G. Wood, and R. H. Carlson. 1976. Tolerance in methylphenidate-induced locomotor activity in prairie dogs (*Cynomys ludovicianus*). Psychopharmacologia 46:111-113.

151. Severe, D. S. 1977. Revegetation of black-tail prairie dog mounds on shortgrass prairie in Colorado. M.S. Thesis, Colorado State Univ., Ft. Collins, 92 pp.

Plant species composition and aboveground biomass were measured in early and late summer 1976 on three black-tail prairie dog towns in Northeastern Colorado. The study was a continuation of research started earlier on the effects of prairie dogs on shortgrass vegetation.

The species of plants and their aboveground biomass production progressively diminished toward the centers of "dome" and "crater"-shaped prairie dog mounds. Feeding, clipping of plants and disturbances of the soil from digging by prairie dogs resulted in the production of "bands" of vegetation surrounding the mounds. The influences of prairie dogs on the vegetation were very similar around the "dome" and the "crater"-shaped mounds, minor variations being associated with the differences in methods of construction of the two mound types.

Annual and short-lived perennial plant species which were not important foods of prairie dogs appeared to increase in frequency and in biomass at about 1 to 2 meters from the centers of mounds. Annual forbs invaded and flourished on abandoned mounds after removal, or reduction in densities of prairie dog populations. Beyond 3.5 meters from the mounds, the plant species and their biomass were not noticeably different from the vegetation at distances of 10 meters or more from any mound.

Significant differences in the vegetation surrounding black-tail prairie dog mounds were found among dogtowns,

sampling dates and distances from mounds. These relationships are described in this thesis. (abstract)

152. Slobodchikoff, C. N., and R. Coast. 1980. Dialects in the alarm calls of prairie dogs. Behav. Ecol. Sociobiol. 7:49-53.

1. The alarm calls of the Gunnison's prairie dog, (*Cynomys gunnisoni zuniensis*), have differentiated into local dialects.
2. Call characteristics show that, within a given dialect, the number of syllables, the length of the syllables, and the interval length between syllables are weakly correlated with one another. The number of syllables, however, is strongly correlated with the total length of the call.
3. Both the number of syllables and the total call length are strongly correlated with the complexity of the habitat: the more complex the habitat in terms of vegetation cover, rocks, and tree stumps, the more syllables there are and the longer is the call. This may be related to predation pressure, with prairie dogs in more complex habitats calling longer to warn their kin when a predator approaches. (summary)

153. Smith, A. S. 1982. Comparative study of the forelimb of the semi-fossorial prairie dog, *Cynomys gunnisoni*, and the scansorial fox squirrel, *Sciurus niger*. Ph.D. Dissert., Northern Arizona University, Flagstaff, 76 pp.

A comparative study of the forelimb of the semi-fossorial prairie dog, Cynomys gunnisoni, and a tree squirrel, Sciurus niger, was focused on possible characteristics for digging in the former and climbing in the latter. These activities were observed in the field and filmed in special indoor chambers. Predictions based on lever arm mechanics alone were that the prairie' dog forelimb would be designed to produce force and the fox squirrel's designed to increase velocity. Out-force and lever arm measurements were made on the shoulder, elbow and wrist joints. Results demonstrated that the fox squirrel produced a larger torque (out-force times out-lever) in 70 percent of the joint angles compared at the shoulder, elbow and wrist.

It was determined for the elbow joint that even though the bony process, olescranon, was on the average shorter in the fox squirrel than the prairie dog (8.0 millimeters vs 8.8 millimeters), the mean effective in-lever (pivot to line of pull of the muscle) tended to be slightly longer.

The fox squirrel had mean contraction times that were faster than the prairie dog (except for latissimus dorsi where they were identical). If the contraction time can be related to velocity of contraction, this characteristic may aid to increase the speed of climbing.

The prairie dog produced sizeable out-forces related to digging and had muscles that were on the average less fatigable than those of the fox squirrel.

It appears that it may have required only minor modifications in the forelimb for the two species to become successful in their scansorial and semi-fossorial life styles.

154. Smith, W. J., S. L. Smith, E. C. Oppenheimer, J. G. DeVilla, and F. A. Ulmer. 1973. Behavior of a captive population of black-tailed prairie dogs: annual cycle of social behavior. Behavior, XLVI:12-220.

A colony of black-tailed prairie dogs (*Cynomys ludovicianus*) in the Philadelphia zoo is being used for long term studies of various aspects of social behavior including pattern of social organization, stylized means of communication, and the effects of individual behavioral differences on communication and social structure. This report deals with the annual cycle of social behavior manifested by the colony during the the first three years of study. (synopsis)

155. ———, S. L. Smith, J. G. DeVilla, and E. C. Oppenheimer. 1976. The jump-yip display of the black-tailed prairie dog *Cynomys ludovicianus*. Anim. Behav. 24:609-621.

A frequent behavior pattern of *Cynomys ludovicianus* is a formalized upward leap with a sharp vocalization: the 'jump-yip' display. It is performed in very diverse circumstances by individuals who have been startled, are being cautious, or have been involved with territorial defense. They behave in various ways, here divided into eight categories, but in all cases are less likely to flee after jump-yipping than immediately before. Virtually any act in its repertoire other than escape may then follow, although attack is rare. Providing information about the relative probabilities of escape and alternative acts appears to be very important in the complex interactions of this unusually social ground squirrel. (abstract)

156. ———, S. L. Smith, E. C. Oppenheimer, and J. G. DeVilla. 1977. Vocalizations of the black-tailed prairie dog, *Cynomys ludovicianus*. Anim. Behav. 25:152-164.

Seven variable vocal displays of *Cynomys ludovicianus* were studied in a captive colony, and checked through limited field work and literature reports. The form of each display makes available information identifying its user. In addition, since each display correlates probabilistically with a consistent set of activities, it makes available information about the behavior in which the communicator is, or may become, engaged. At least five different kinds of behavior can be specified through the use of these displays. (abstract)

157. Snell, G. P. 1985. Results of control of prairie dogs. Rangelands 7(1):30.

When the article, "Control of Prairie Dogs—The Easy Way," appeared in the December 1980 issue of "Rangelands", Bob Larson, an Earber County, Kansas rancher, had drastically reduced his prairie dog town after 4 years of deferred grazing during June, July, and August. Largely because the rapidly growing warm-season plants hid predators and obstructed visibility for the prairie dogs. The town area dropped from 110 acres in 1976 to 12 acres by the fall of 1980.

In 1981 and 1982 Larson left a "few" cattle which amounted to about 5 percent of the stocking capacity. But they concentrated on the prairie dog town. At the end of 1981 the burrowed area had grown to 15 acres. By the fall of 1982 it was up to 20 acres.

In 1983 Bob again totally deferred that pasture from grazing during June, July, and August. That fall the prairie dog area measured just 5.7 acres. This is dramatic evidence of how deferred grazing can check prairie dog development.

158. _____, and B. D. Hlavachick. 1980. Control of prairie dogs—the easy way. Rangelands 2(6):239-240.

One Kansas rancher is effectively reducing his prairie dog problem by using natural biological controls and good range management. (synopsis)

159. Stinnett, S. S. 1981. Food habits and effects of Gunnison's, Zuni, and black-tailed prairie dogs on plant communities in New Mexico. M.S. Thesis, New Mexico State Univ., Las Cruces, 138 pp.

The purpose of this study was to determine the food habits of three populations of prairie dogs in New Mexico. A secondary interest was to determine the prairie dogs' effects on range plant communities.

Three active prairie dog towns were used as study sites. Data were collected in late summer 1979, fall 1979, spring 1980, early summer 1980 and late summer 1980. Cover, botanical composition and standing crop data were collected for vegetational analysis and stomach samples were collected for dietary analysis.

Grasses were the main constituents in the diets of both the black-tailed (*Cynomys ludovicianus*) and Gunnison's (*Cynomys gunnisoni gunnisoni*) prairie dogs. Forbs were the main components of the diets of the Zuni (*Cynomys gunnisoni zuniensis*) prairie dogs. During dry periods, prairie dogs increased their intake of forbs and shrubs to metabolize water. Consumption of forbs also increased in the fall before the Gunnison's and Zuni prairie dogs hibernated. The favorite food items of the two species of prairie dogs were blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), crested wheatgrass (*Agropyron cristatum*), narrowleaf goosefoot (*Chenopodium leptophyllum*), Russian thistle (*Salsola kali*), scarlet globemallow (*Sphaeralcea coccinea*) and big sage (*Artemisia tridentata*).

The activities of the two species of prairie dogs increased the number of plant species present in their towns, both annuals and perennials. The cover, botanical composition and standing crop of perennials was greater than that of the annual species for all three sites.

160. Stockrahm, D. M. R. B. 1979. Comparison of population structure of black-tailed prairie dog towns in southwestern North Dakota. M.S. Thesis, Univ. North Dakota, Grand Forks, 103 pp.

The purpose of this study was to determine the age structures, sex ratios, ecological longevity, and reproductive performence of black-tailed prairie dog (*Cynamys indovicianus*) populations differing in size and history, especially regarding degree of human disturbance.

A total of 469 prairie dogs were collected from four dog towns in central Billings County, North Dakota from 29 May to 26 July 1977 and aged by tooth eruption and wear, skull ossification, epiphyseal closure, dry lens weight, and tooth cementum annuli. Placental scar counts were used to approximate litter size. Physical features and histories of towns were determined.

Pooled data for disturbed versus undisturbed towns revealed that sex ratios were significantly different from 1:1 in the disturbed towns for the 2-to-3-year age class ($p<0.05$), total adult group (i.e., 1,2, and 3-year-olds) ($p<0.01$), and total town group (pups plus total adults)($p<0.05$). In the undisturbed towns only the 2-to-3-year age class had a sex ratio significantly different from 1:1 ($p<0.01$). In nearly all cases, sex ratios were more skewed against males in the disturbed towns than in the undisturbed towns.

Females generally outlived males. Ecological longevity of prairie dogs in North Dakota appears to be 3 years, but males rarely reach this age. Mortality of young between the time of implantation and emergence may be as great as 50 percent.

Many yearlings in disturbed towns failed to ovulate, while nearly all females in the undisturbed towns had ovulated and had placental scars. Heavy hunting pressure in the disturbed towns possibly adversely affected physical growth by allowing less time to forage. The net reproductive rate (R) of 2.145 and innate capacity for increase (r) of 0.50 for an undisturbed town indicated that population growth of black-tailed prairie dogs in North Dakota was not as rapid as other authors have implied.

Hunting pressure, at least in small towns, seems to affect population structure and reproductive performance as evidenced by skewed sex ratios against males and lack of breeding yearlings in disturbed towns. (abstract)

161. Stromberg, M. R. 1974. Group response in black-tailed prairie dogs to an avian predator. J. Mamm. 55(4):850-851.

Numerous foraging black-tailed prairie dogs (*Cynomys ludovicianus*) took refuge in their burrows as a red-tailed hawk (*Buteo jamaicensis*) approached, although a few remained above ground near burrow entrances in upright, alert postures. The hawk circled for 30 minutes as numerous prairie dogs appeared above ground but remained near to their burrow entrances. After gradually increasing its altitude and circle diameter, the hawk dove, struck a prairie dog and killed it. After preening, the hawk was attacked by prairie dogs three times as it began feeding, until it flew away. (abstract)

162. _____. 1975. Habitat relationships of the black-tailed prairie dog (*Cynomys ludovicianus*), vegetation, soils, comparative burrow structure and spatial patterns. Unpubl. M.S. Thesis, Univ. Wisconsin, Madison, 175 pp.

This thesis discusses vegetation, effects of prairie dogs on soil, comparative burrow structure, and comparative spatial pattern of burrow entrances. (synopsis)

163. _____. 1975. A method for non-destructive study of ground-squirrel tunnels. 55th Amer. Society of Mammalogy Annual Meeting. Missoula, Montana. Tech. Paper No. 94.

164. _____. 1978. Subsurface burrow connections and entrance pattern of prairie dogs. Southwestern Nat. spatial 23(2):173-180.

White-tailed and black-tailed (*Cynomys leucurns) (C. ludovicianns*) prairie dog colonies in Wyoming were mapped. In place of excavation, smoke was forced into entrances to determine connections. Maps allowed a plotless analysis of spatial pattern. Black-tailed prairie dog entrances showed a random or regular distribution and white-tailed prairie dogs showed an aggregated entrance pattern. Connections between entrances may be fewer than previously thought. Black-footed ferrets (*Mustella nigripes*) may selectively occupy the most complex and rare burrow systems. (abstract)

165. Sullins, M. 1977. Evaluation of prebaiting for improving bait acceptance by black-tailed prairie dogs. Dept. of Livestock Report, 2 pp.

Three baiting trials were conducted in Big Horn and Custer counties, Montana, during July, September, and October, 1977. Prebaiting with nontoxic steam-rolled oats prior to applying strychnine and zinc phosphide baits resulted in an 89 percent or greater reduction in prairie dog activity. Less than 89 percent reduction in activity of prairie dogs was obtained in all cases where prebait was not used. Prebaiting increased control costs by 25 to 50 percent. (abstract)

166. ———. 1979. Efficacy and cost of cyclone seeders, motorcycle dispensers, and hand baiting for controlling black-tailed prairie dogs. Montana Dept. of Livestock Report, 8 pp.

Field evaluations were conducted in Custer County, Montana, during August 1979 to compare three methods of applying bait for controlling black-tailed prairie dogs (*Cynomys ludovicianns*). Strychnine bait applied by mechanical disensers mounted on three-wheeled, all-terrain vehicles (ATV) reduced prairie dog activity by 88 percent at a cost of $0.62 per acre. Cost for hand baiting was $0.91 per acre resulting in a 74 percent reduction in prairie dog activity. Broadcast and strip applications with the cyclone seeder were the fastest methods but required a cost of $6.77 and $2.77 per acre respectively, for a 78 percent reduction in activity. The cycle-mounted dispenser was the most efficient and cost effective application method tested.

167. ———. 1980. Efficacy of strychnine and zinc phosphide baits for controlling black-tailed prairie dogs. Montana Dept. of Livestock Report, 3 pp.

Field evaluations were conducted in Custer County, Montana, during August 1979 to determine the comparative effectiveness of strychnine and zinc phosphide baits in reducing numbers of black-tailed prairie dogs. Prairie dog activity was reduced by 97.6 and 86.0 percent with strychnine, and 95.0 and 95.5 percent with zinc phosphide-treated sites. No major differences in efficacy were noted.

168. ———. 1980. A field comparison of strychnine, zinc phosphide and 1080 grain baits for controlling black-tailed prairie dogs. Montana Dept. of Livestock Report, 6 pp.

A field investigation conducted in Custer County, Montana, during August 1980, determined that prairie dog activity was reduced on strychnine, prebaited strychnine, prebaited zinc phosphide, and 1080-treated sites by 87.4, 95.7, 95.6, and 84.6 percent respectively. Only seven prairie dog carcasses were found above ground (six on the zinc phosphide site and one on the prebaited strychnine site). Seven non-target species carcasses were found on the strychnine-treated plots.

169. ———. 1981. A field comparison of 0.20, 0.35, and 0.50 percent strychnine grain baits for controlling black-tailed prairie dogs. Montana Dept. of Agriculture, Tech. Rept. 81-4, 4 pp.

A field investigation conducted in Petroleum County, Montana, during August 1981, determined that strychnine grain bait containing 0.20 percent active ingredient was not as effective as 0.35 and 0.50 percent baits in reducing prairie dog numbers. Four non-target species, horned lark, carcasses were found on the treated plots.

170. ———. 1982. Efficacy of diphacinone baits for controlling black-tailed prairie dogs. Montana Dept. of Agriculture, Tech. Rept. 82-6.

171. ———. 1982. Efficacy of strychnine bait placed inside burrows for controlling black-tailed prairie dogs. Montana Dept. of Agriculture, Tech. Rept. 82-5, 8 pp.

172. Summers, C. A. 1976. Key to microscopic fragments of plant tissue in prairie dog stomachs and food habits of prairie dogs in South Dakota. M.S. Thesis, South Dakota State Univ., Brookings, 129 pp.

The purposes of this study were to: (1) develop a reference collection and construct a key of plants occurring on prairie dog towns in southwest South Dakota; (2) determine plant species eaten by prairie dogs by analyzing stomach and pellet samples; and (3) relate the availability of plant species and preference in the feeding habits of prairie dogs.

Two prairie dog towns of different vegetation were studied. Four burrows in each of two vegetative types for each town were randomly selected. Prairie dogs and pellet samples were collected from these burrows and plant cover was measured in four concentric circles for each burrow. Spring, summer, and winter collections were made in 1973.

Slides of leaf, stem, root, flower, and seed material were made for each species in the study areas. Species of grasses and sedges were identified by the occurrence, position, and shape of epidermal structures: macrohairs, microhairs, prickle hairs, papillae, stomata, long cells, short cells, and silica bodies. Diagnostic characteristics of leaf and stem material of forbs were the occurrence, shape, and position of certain epidermal structures: trichomes, stomata, subsidiary cells, crystals, cell walls, and cuticle. The ability of the investigator to recognize the reference species was demonstrated by analyzing unknown mixtures.

Five major plant species were found to be important in stomach and pellet samples: buffalograss (*Buchloe dactyloides*), scarlet globemallow (*Sphaeralcea coccinea*), threadleaf sedge (*Carex filifolia*), blue grama (*Bouteloua gracilis*), and western wheatgrass (*Agropyron smithii*). Seasonal dif-

ferences for spring and summer were not significant ($p>0.05$). Insect matter and seed material were not important (less than 5 percent). Winter food habits showed an increase in importance of pricklypear cactus (*Opuntia polyacantha*) and western wheatgrass and a decline in the other major species There was no increase in root material in winter.

Prairie dogs were selective in their feeding habits. Three species important in the range but avoided in feeding were three-awn (*Aristida fendleriana and A. longiseta*), prairie dogweed (*Dyssodia papposa*), and horseweed (*Conyza ramosissima*). Results of this study did not differ greatly from other studies except that buffalograss comprised the greatest percentage of the stomach contents.

173. ____, and R. L. Linder. 1978. Food habits of the black-tailed prairie dog in western South Dakota. J. Range. Mgmt. 31(2):134-136.

Five major plant species were important in stomach and pellet samples of prairie dogs from two different "towns" in western South Dakota. Buffalograss (*Buchloe dactyloides*), scarlet globemallow (*Sphaeralcea coccinea*), and western wheatgrass (*Agropyron smithii*). Seasonal differences for spring and summer diets were not significant (p.05). During winter, pricklypear cactus (*Opuntia polyacantha*) and western wheatgrass increased in importance in diets and the other major species declined in importance. Three species important in the range but not important in the diet were threeawn (*Aristida fendleriana and A, longiseta*), prairie dogweed (*Dyssodia papposa*), and horseweed (*Conyza ramosissima*). (abstract)

174. Swick, C. D. 1976. A field evaluation of strychnine, zinc phosphide and 1080 grain baits for prairie dog control Montana Dept. of Livestock Report, Helena, 8 pp.

Bait efficacy trials for prairie dog control were conducted in Big Horn County during August, 1976. Prairie dog numbers were reduced 33 percent using 1.0 percent zinc phosphide on oat groats, 30 percent using 2.0 percent zinc phosphide on steam-rolled oats, 57 percent using 0.44 percent strychnine on whole oats, and 92 percent using 0.05 percent 1080 on oats groats. Small mammal (rodent) populations were reduced at each test site, but no other non-target species were observed to have been affected.

175. ____. 1978. Reproduction of black-tailed prairie dogs with reference to grain acceptance in southwest Montana. Montana Dept. of Livestock Rept., 2 pp.

176. Tietjen, H. P. 1976. Zinc phosphide—its development as a control agent for black-tailed prairie dogs. U.S.D.I., U.S. Fish Wildl. Serv., Spec. Sci. Rep. Wildl. 195, Washington, D.C., 14 pp.

A program was undertaken to develop zinc phosphide as a replacement for the more hazardous toxicants currently available to control black-tailed prairie dogs (*Cynomys ludovicianus*). Laboratory grain acceptance tests, LD determinations, and bait development bioassays led to selection of 2 percent zinc phosphide-treated oats. In 30-day secondary hazard bioassays, minks (*Mustela vison*) showed no effects from eating entire carcasses of prairie dogs killed with this bait. Four field trials at 15 black-tailed prairie dog colonies in Montana, Colorado, and Nebraska resulted in consistently high reductions in prairie dog activity (76-96 percent) when colonies were prebaited and the bait was applied in surface bait spots at the low rate of 4 grams per burrow. Extensive surveys during these trials revealed no primary or secondary hazards to any non-target species. Experiments to measure zinc phosphide residues in range vegetation demonstrated that baiting, even at a much higher rate than 4 grams per burrow, caused virtually no environmental contamination. This series of studies produced a recommended method for control of black-tailed prairie dogs: prebaiting followed by one surface application, at 4 grams per burrow, of a bait formulated from steam-rolled oats, 2 percent zinc phosphide, and 1 percent corn oil. All evidence from the laboratory and field tests indicates that this treatment is effective and safe, and that the risk of its resulting in either primary or secondary intoxication of non-target vertebrates, including black-footed ferrets (*Mustela nigripes*), is remote. (abstract)

177. ____. 1976. Zincphosphide—a control agent for black-tailed prairie dogs. U.S. Dept. Inter., Fish and Wildl. Serv. Leafl. No. 509, 4 pp.

The U.S. Fish and Wildlife Service recognized as early as 1969 that the rodenticides then in use (strychine and 1080) posed a potential hazard to a variety of non-target species living in or adjacent to treated black-tailed prairie dog colonies. Zinc phosphide was developed as a replacement. This document presents operational guidelines for the use of zinc phosphide. This includes use instructions, materials and techniques, the grain carrier and formulation, timing of control operations (prebaiting, baiting), frequency of control operations have responsible control.

178. ____, J. F. Glahn, and K. A. Fagerstone. 1978. Aerial photogrammetry: a method for defining black-tailed prairie dog colony dynamics. Pp. 244-247 *in* PECORA IV Symposium on Application of Remote Sensing Data to Wildlife Management. Sioux Falls, South Dakota.

Remote sensing by vertical aerial photogrammetry was evaluated as a means for plotting the distribution and size of black-tailed prairie dog (*Cynomys ludovicianus*) colonies in South Dakota. An analysis of 1:15,840 scale 9-by-9 inch black and white contact prints spanning a 5-year period shows this technique to be useful for plotting colony location and size and may provide the basis for modeling changes in colony dynamics. (abstract)

179. ____, and G. Matschke. 1982. Aerial prebaiting for management of prairie dogs with zinc phosphide. J. Wildl. Mgmt. 46(4):1108-1112.

Study objectives were to evaluate aerially applied prebait regimes, specifically their potential for maintaining the high treatment response associated with surface (spot) pre-

baiting by hand as identified on the current federal label, and reducing treatment time to levels similar to the more efficient and hazardous 1080. They concluded that aerial prebaiting followed by hand-applied surface baiting provides effective control and reduces the time, manpower, and expenses associated with current control methodology.

180. Todd, G. E., and D. C. Cogan. 1978. Selected schedules of reinforcement in the black-tailed prairie dog (*Cynomys ludovicianus*). Anim. Learn. Behav. 6:429-434.

Wild black-tailed prairie dogs were run on FR, FI, VR, and VI schedules for Noyes pellet reinforcement. Cumulative barpress responses, postreinforcement pause lengths, and responses per second were recorded. The highest response rates occurred in the VR schedules, with the lowest response rates coming in the FI schedules. Fixed-ratio schedules had the longest postreinforcement pauses, VI schedules had the shortest. At the upper levels of the fixed-ratio schedules (FR 90-100), the animals ceased to respond consistently. Generally, data from prairie dogs were consistent with data reported in studies from other mammalian species.

181. Uresk, D. W. 1984. Black-tailed prairie dog food habits and forage relationships in western South Dakota. J. Range. Mgmt. 37(4):325-329.

Four plants made up 65 percent of items in fecal pellets of the black-tailed prairie dog in western South Dakota. These important forages in order of significance were sand dropseed, sun sedge, blue grama, and wheatgrasses. Grasses made up 87 percent of the total diet, while forbs comprised 12 percent. Shrubs, arthropods, and seeds made up 1 percent or less of the diet. Preference indices were highest for ring muhly, green needlegrass, and sand dropseed. Relationships of diets to available forage was weak, having an average similarity of 25 percent; rank-order correlations were nonsignificant, indicating that black-tailed prairie dogs are selective feeders. (abstract)

182. ———. 1985. Effects of controlling black-tailed prairie dogs on plant production. J. Range Mgmt. 38(5):466-468.

Plant production of 43 plant species was evaluated for three treatments after poisoning black-tailed prairie dogs (*Cynomys ludovicianus*) on rangelands in western South Dakota. The three pre-poison treatments were ungrazed (no cattle or prairie dogs), prairie dogs only, and cattle plus prairie dogs. Western wheatgrass (*Agropyron smithii*) had lower production on the prairie dog, and cattle-prairie dog treatments 4 years after prairie dog control, when compared with no grazing. Buffalograss (*Buchloe dactyloides*) showed a decrease in production on the cattle plus prairie dog grazing treatment, when compared to not grazing. Production of needleleaf sedge (*Carex eleocharis*) was lower on the cattle-prairie dog treatment, when compared to the prairie dog treatment. No other significant differences were observed over the 4-year period among the three treatments for all other species, including grass and forb categories. Prairie dog control did not increase plant production over a 4-year period. Additional time with reduced livestock grazing may be required to increase forage production.

183. ———, and A. J. Bjugstad. 1980. Cattle-Prairie dog forage relationships on the northern high plains. Soc. Range Mgmt. Annu. Meeting 33:32.

Information on cattle-prairie dog forage relationships has been a major concern on the Northern High Plains in recent years with the increase in the prairie dog populations. Four treatments were used: (1) no grazing after four consecutive growing seasons, (2) grazing by prairie dogs after four consecutive seasons, (3) grazing by cattle and prairie dogs and, (4) forage utilized by both animals. Standing crop values were obtained on all treatments by plant species, and forage utilization was assessed by harvesting under cages. Grazing by prairie dogs only had the highest standing crop values followed by no grazing, and grazing by cattle and prairie dogs. Data are presented on relationships and forage utilization by both animals.

184. ———, and A. J. Bjugstad. 1980. Prairie dogs as ecosystem regulators on the Northern High Plains. Pp. 91-94 *in* Proc. 7th North American Prairie Conference (C. L. Kucera, ed.). Southwest Missouri State Univ., Springfield.

The increase in prairie dog populations on the northern high plains has emphasized the need for additional information on cattle-prairie dog forage relationships. To obtain information on cattle-prairie dog forage relationships, four treatments were evaluated over four growing seasons. These treatments were: (1) no grazing (prairie dogs eliminated and cattle excluded), (2) grazing by prairie dogs, (3) grazing by cattle and, (4) grazing by cattle and prairie dogs. In addition, forage utilized by cattle and prairie dogs was assessed. Standing crop values were obtained on all treatments by plant species under cages, and forage utilization was assessed by harvesting under cages and outside cages. Results indicate major differences among treatments. Peak standing crop values on the prairie dog treatment was 24 percent higher when compared to the cattle only grazing treatment. Cattle plus prairie dogs was 13 percent higher than the cattle treatment followed by no grazing, which was about equal with a 2 percent increase. Grasses showed an increase on both the no grazing, cattle plus prairie dog treatments (4 percent) followed by a decrease on the prairie dog treatment (-6 percent) when compared to the cattle treatment only. Forbs increased on the prairie dog treatment (+165 percent) followed by no grazing (+91 percent), and the cattle plus prairie dog treatment (+76 percent) when compared to the cattle treatment. Utilization by cattle and prairie dogs was 37 percent in June and 56 percent in August. After 4 years active prairie dog burrows were highest on the prairie dog plus cattle treatment with 95/acre, while on the prairie dog treatment 43/acre were present. Data on standing crop values are presented for prairie dog-cattle relationships by treatments and forage utilization. (abstract)

185. ———, and A. J. Bjugstad. 1981. Effects of prairie dogs and cattle on vegetation of the Northern High Plains. South Dakota Stockgrower, May:10,27-28.

Peak plant production of above ground herbage over a 5-year period where only prairie dogs grazed, was higher

during the last four years than those under three other treatments. (synopsis)

186. ———, J. D. MacCracken, and A. J. Bjugstad. 1981. Prairie dog density and cattle grazing relationships. Pp. 199-201 *in* Proc. Fifth Great Plains Wildlife Damage Control Workshop (R. M. Timm and R. J. Johnson, eds.). Institute of Agriculture and Natural Resources, Univ. Nebraska, Lincoln.

Black-tailed prairie dogs (*Cynomys ludovicianus*) were more abundant ($p<0.01$) in areas of southwestern South Dakota heavily grazed by cattle than in areas where cattle were excluded. Results suggest that periodic exclusions or reduced cattle stocking rates, in combination with control programs, help regulate prairie dog population increase and expansion as indexed by burrow counts. (abstract)

187. U.S.D.A. Forest Service. 1977. Prairie dog management. Draft Environ. Impact Statement, 92 pp.

188. ———. 1978. Management of prairie dogs on lands administered by the supervisor of the Nebraska National Forest. E.S. USDA-FS-R2-FES, Chadron, 188 pp.

This proposal is to implement a management plan for prairie dogs on the public lands administered by the supervisor of the Nebraska National Forest. These lands are located in southwestern South Dakota and northwestern Nebraska. A feature of the plan is to manage prairie dogs on a 92-square mile area of the Buffalo Gap National Grassland to protect habitat for the black-footed ferret. (synopsis)

189. ———. 1981. Thunder Basin prairie dog management. Final Environ. Impact Statement, Medicine Bow National Forest, Laramie, Wyoming, 76 pp. + appendices.

This environmental assessment documents the analysis of prairie dog management alternatives and their effects on Thunder Basin National Grassland. Four alternatives were generated. Alternative IV, management of prairie dogs on Federal land to reduce possible impact to private and State lands and to provide multiple-use of Federal lands (at least 5,400 acres), is the Forest Service's Selected alternative because it provides the best mix of multiple-use values and best reconciles public issues, management concerns and assessment objectives at a considerably more cost effective level than the other alternatives. (abstract)

190. USDI Bureau of Land Management. 1982. Black-tailed prairie dog-control/management in Phillips Resource Area. Programmatic environmental assessment. BLM, Lewiston District, Phillips Resource Area, Malta, Montana, 40 pp. + appendices.

This document compares the environmental consequences of implementing each of three alternatives considered. (synopsis)

191. ———. 1985. Prairie dog ecosystem habitat management plan. Prepared by S. G. Coy and D. A. Roberts. BLM Publ. No. WY-010-WHA-T14, Worland District, Cody Resource Area, Worland, Wyoming, 178 pp. + appendices.

192. National Park Service. 1982. Prairie dog management plan (WICA-N-0001). Wind Cave National Park, Rocky Mountain Region, Denver, Colorado, 9 pp.

Integration of zinc phosphide treatment along with reduction of elk and bison herds to lower than normal levels and use of DES chemosterilant were the alternatives chosen to reduce prairie dog numbers within the park. (synopsis)

193. Vogel, S., C. P. Ellington Jr., and D. L. Kilgore Jr. 1973. Wind-induced ventilation of the burrow of the prairie dog, *Cynomys ludovicianus*. J. Comp. Physiol. 85:1-14.

Where a fluid flows across a surface, such as wind over the earth, the velocity gradient created provides a potential source of work. This gradient might be employed by one burrowing animal to induce air-flow in its long, narrow burrow. The burrow of the black-tailed prairie dog constitutes a respiratory dead-space of extraordinary magnitude in which diffusion appears inadequate for gas exchange. But the burrow is arranged in a manner appropriate for wind-induced ventilation, typically with two openings at opposite ends and with mounds surrounding these openings of two forms, with one form on each end.

When a breeze crosses the mounds, air enters the burrow through the lower mound and leaves through the higher. The same unidirectional flow is evident with scale models of real mounds on a model burrow in a wind tunnel. Flow inside the burrow is nearly a linear function of flow across the mounds. Wind-induced ventilation in the model burrow could also be induced with model mounds differing in shape but not in height. Mounds with sharp rims were more effective exits for air than mounds with rounded tops. In nature such shape differences complement the differences in height. (abstract)

194. Wallace, G. M., H. R. Fevold, and E. W. Pfeiffer. 1984. Urea hydrolysis on black-tailed prairie dogs (*Cynomys ludovicianus*). Comp. Biochem. Physiol. 78A:279-283.

1. Urea hydrolysis was compared between winter fed (control) and food and water deprived prairie dogs by measuring the percentage recovery of an injected 14C-Urea tracer in the animals' expired air. 2. Plasma and urine urea concentrations, 24 hour urea excretion, urin osmolality and respiratory exchange ratios (R) were compared between groups. 3. Food and water deprived animals expired significantly less 14CO than did control animals (3.4 vs 9.3 percent, respectively). 4. Food and water deprived animals had lower plasma urea concentrations (6.1 mM) and lower 24 hour urea excretions (0.07 g) than did control animals (8.1 nM and 0.34 gram, respectiely). 5. Urine osmolalities ranged from 364 to 737 mOsm in control animals and from 417 to 2168 mOsm in food and water deprived animals. 6. R values of 0.72 and 0.66

were determined for control and food and water deprived animals, respectively, indication that fat was the principal fuel source. 7. These findings are discussed as possible adaptations to xeric living conditions.

195. Welch, W. R. 1980. Evaporative water loss from endotherms in thermally and hygrically complex environments: an empirical approach for interspecific comparisons. J. Comp. Physiol. 139:135-143.

Evaporative water loss was measured from black-tailed prairie dogs (*Cynomys ludovicianus*) at eight air temperature between 10 and 40 C, and over a broad range of humidities at each temperature. Evaporation increased, decreased, or remained constant below thermoneutrality, depending on humidity, and increased at higher temperatures indirectly with humidity. Evaporation was negatively related to humidity at different temperatures with a series of linear regressions that provided for statistical comparisons. Significantly different intercepts and slopes at different temperatures occurred for prairie dogs, and for deer mice (*Peromyscus maniculatus*) and house mice (*Mus musculus*) using published data. A general model, based on the equation for a straight line, was developed to relate evaporation to humidity; the intercept and slope were empirically derived mathematical functions of temperature. The model provided three-dimensional graphic responses for evaporation that showed different interactions between temperature and humidity for the three species. (abstract)

196. Woodis, S. G. 1981. Longevity of simulated ferret trenches on black-tailed prairie dog colonies. J. Colorado-Wyoming Acad. Sci. 13(1):63-64.

A study was conducted on three black-tailed prairie dog (*Cynomys ludovicianus*) colonies using siberian polecat (*Mustela eversmanni*) scent on simulated black-footed ferret (*Mustela nigripes*) trenches to determine if the characteristic response of the black-tailed prairie dogs to the black-footed ferret (burrow entrance plugging and trench destruction) would be elicited. The trench longevity after construction was recorded. A total of 90 trenches were constructed, 30 morning scented, 30 evening scented and 30 control or unscented. It was found that there was no significant difference between the time to destruction of the three trench types during the month of October, 1979.

197. Woolf, A., J. King and B. Tennant. 1982. Primary hepatocellular carcinoma in a black-tailed prairie dog. J. Wildl. Dis. 18(4):517-518.

A colony of black-tail prairie dogs (*Cynomys ludovicianus*) in the Highland Park Zoo, Pittsburgh, Pennsylvania was found to have a remarkably high prevalence of chronic hepatitis and hepatocellular carcinoma. This study investigated the etiology and found that physical and biochemical characteristics showed it to be similar to the human hepatitis B virus.

198. Wright-Smith, M. A. 1978. The ecology and social organization of *Cynomys parvidens* (Utah Prairie Dog) in southcentral Utah. M.A. Thesis, Indiana University, Bloomington, 44 pp.

Basic ecological and behavioral aspects of the Utah prairie dog were investigated at two sites near Bryce Canyon National Park in southern Utah during the late spring-early summer seasons of 1975 and 1976. A relatively low density colony (5 to 11/hectare), occupying a sage grassland, and a relatively high density colony (40/hectacre), on an abandoned alfalfa farm, were chosen to correct for density as a confounding factor in the study.

Prairie dogs were diurnal with a daily bimodal activity pattern in June and July. Weights of adult males were greater than weights of adult females, but weights of all prairie dogs tended to increase throughout the summer. Yearlings were important in the Utah prairie dog age structure because of their breeding capacity. Dispersal movements included a few adults but primarily involved young prairie dogs. Predation in the colonies was attributed to badgers, weasels, marsh hawks and golden eagles.

The prairie dogs in the two colonies were organized into clans, usually consisting of a male, one to four females, and their young. Dominance hierarchies within the clans were not observed. Geographic boundaries of clans were fairly constant, but territorial behavior was focused mainly on burrows and burrow systems. Feeding areas utilized by more than one clan existed in the colonies. Females took the primary role in caring for young. Using naso-nasal contacts as a gauge of the frequency of social encounters between sex-age classes, adult females and young exhibited the highest percent of the total encounters observed. However, play between young and adults of both sexes was observed commonly and mutual grooming was seen, but uncommonly. Communication of Utah prairie dogs included a repetitious or alarm bark, a laughing bark or "group cohesion" call, a rapid repetitious bark, growling and chattering. A small percent of the Utah prairie dogs' time was spent in social interactions. Most of their time was spent in maintenance activities 58.6 percent and alert behavior 24.6 percent. (abstract)

199. Wydeven, A. P. 1979. Food habits and relationships of elk to other herbivores in Wind Cave National Park. M.S. Thesis, Iowa State Univ., Ames, 208 pp.

200. Wydeven, P. R. 1979. A comparison of prairie dog stomach and fecal material with a microhistological technique. M.S. Thesis, Iowa State Univ., Ames, 50 pp.

201. ———, and R. B. Dahlgren. 1982. A comparison of prairie dog stomach contents and feces using a microhistological technique. J. Wildl. Mgmt. 46(4):1104-1108.

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